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1990-1994

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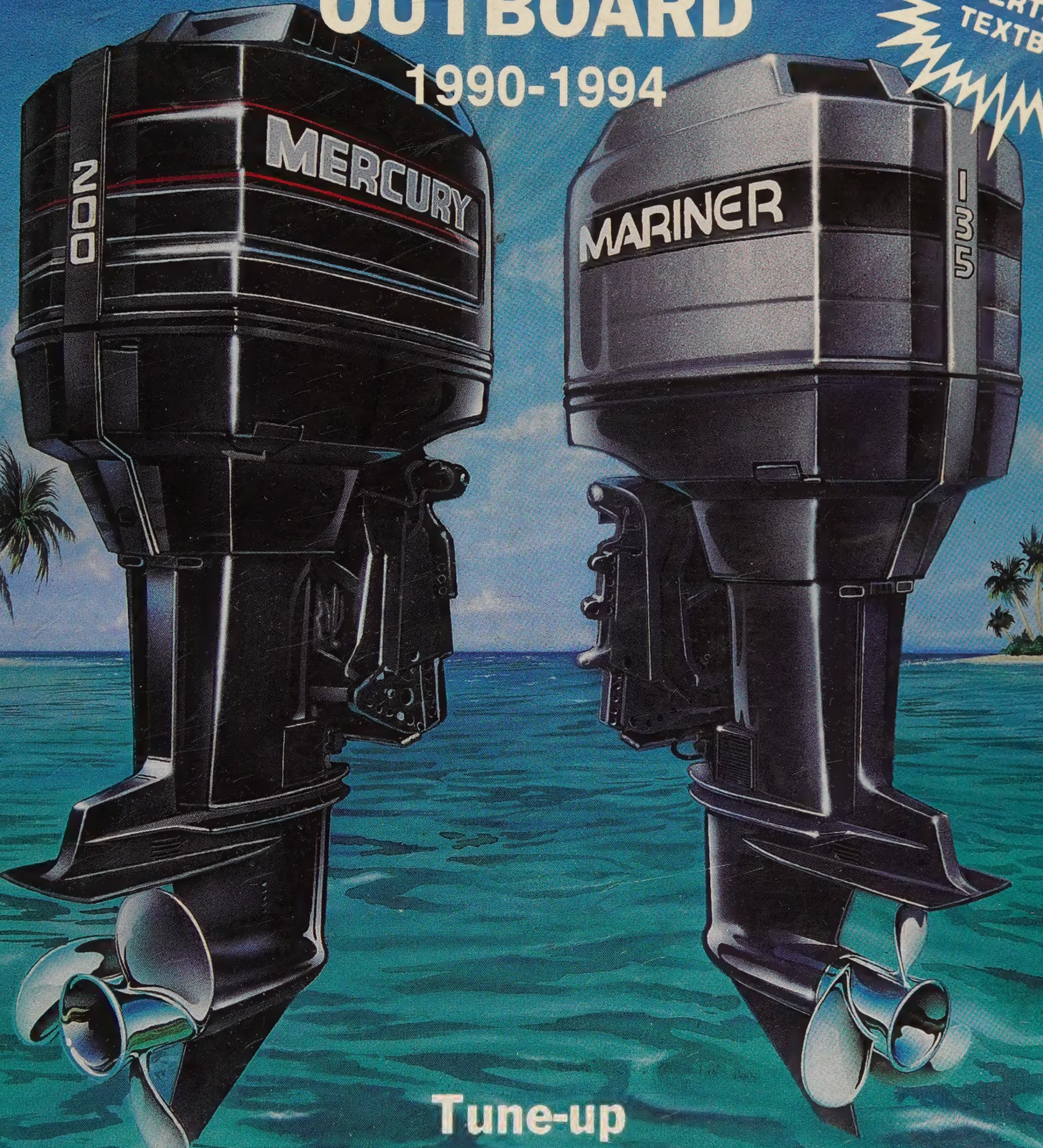

Tune-up and Repair Manual

Joan and Clarence Coles

MERCURY/MARINER

OUTBOARD

Volume III

V6 Powerhead

1990-1994

Tune-up and Repair Manual

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Joan and Clarence Coles

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10693 Civic Center Drive
Rancho Cucamonga, California 91730-3804

ISBN 0-89330-037-3

Printed in the United States of America

FOREWORD

This is a comprehensive tune-up and repair manual for Mercury and Mariner V6 outboard units manufactured from 1990 through 1994. A separate Seloc manual covers Mercury 3- and 4-cylinder units -- 1965 thru 1992 and another separate manual covers not only the Mariner 3- and 4-cylinder units from 1977 through 1989, but also the V6 units. All Seloc manuals have been designed and written for the professional mechanic, the do-it-yourselfer, and the student developing his mechanical skills.

Seloc manuals have accompanied Smithsonian and National Geographic expeditions in tropical areas and on near frozen seas in the Arctic and Antarctic regions.

Professional Mechanics will find it to be an additional "tool" for use in their daily work on V6 Mercury or Mariner units because of the many special helpful techniques described and not found in the factory "shop manuals".

Boating Enthusiasts interested in performing their own work and in keeping their unit operating in the most efficient manner will find the step-by-step illustrated procedures used throughout the manual extremely valuable. In fact, many users have said this book almost equals an experienced mechanic looking over their shoulder giving advice.

Students and **Instructors** have found the chapters divided into practical areas of interest and work. Technical trade schools, from Florida to Michigan and west to California, as well as the U.S. Navy and Coast Guard, have adopted Seloc manuals as a standard classroom text.

Illustration and **Procedural Steps** are so closely related and identified with matching numbers captions are not required. The exploded drawings show internal parts and their relationship with each other.

Troubleshooting sections have been included in many chapters assisting the individual performing the work to quickly and accurately isolate problems to a specific area without unnecessary expense and time-consuming work. As an added aid and one of the unique features of this book, many worn parts are illustrated to identify and clarify when an item should be replaced.

Accurate comprehensive specifications and wiring diagrams are included.

ACKNOWLEDGMENTS

A sincere expression of appreciation and indebtedness is certainly due the Brunswick Corporation -- MERCURY/MARINER -- Fond du Lac, Wisconsin for their generous assistance and permission to use certain illustrations. The exploded drawings and wiring diagrams are a positive contribution to this manual.

A very special thanks is extended to "Sandy" Milligan of B & J Marine, Pomona, California for his patience in answering our numerous technical questions and for making certain units available to us for photographic purposes during the preparation of this manual.

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1
SAFETY

1-1 INTRODUCTION

In order to protect the investment for the boat and outboard, they must be cared for properly while being used and when out of the water. Always store the boat with the bow higher than the stern and be sure to remove the transom drain plug and the inner hull drain plugs. If any type of cover is used to protect the boat, be sure to allow for some movement of air through the hull. Proper ventilation will assure evaporation of any condensation that may form due to changes in temperature and humidity.

1-2 CLEANING, WAXING, AND POLISHING

Any boat should be washed with clear water after each use to remove surface dirt and any salt deposits from use in salt water. Regular rinsing will extend the time between waxing and polishing. It will also give you "pride of ownership", by having a sharp looking piece of equipment. Elbow grease, a mild detergent, and a brush will be required to remove stubborn dirt, oil, and other unsightly deposits.

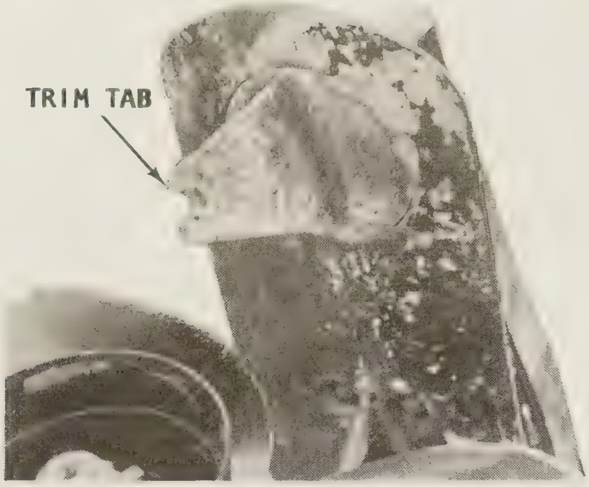
Stay away from harsh abrasives or strong chemical cleaners. A white buffing compound can be used to restore the original gloss to a scratched, dull, or faded area. The finish of your boat should be thoroughly cleaned, buffed, and polished at least once each season. Take care when buffing or polishing with a marine cleaner not to overheat the surface you are working, because you will burn it.

1-3 CONTROLLING CORROSION

Since man first started out on the water, corrosion on his craft has been his enemy. The first form was merely rot in the wood and then it was rust, followed by other forms of destructive corrosion in the more modern materials. One defense against corrosion is to use similar metals throughout the boat. Even though this is difficult to do in designing a new boat, particularly the undersides, similar metals should be used whenever and wherever possible.

A second defense against corrosion is to insulate dissimilar metals. This can be done by using an exterior coating of Sea Skin or by insulating them with plastic or rubber gaskets.

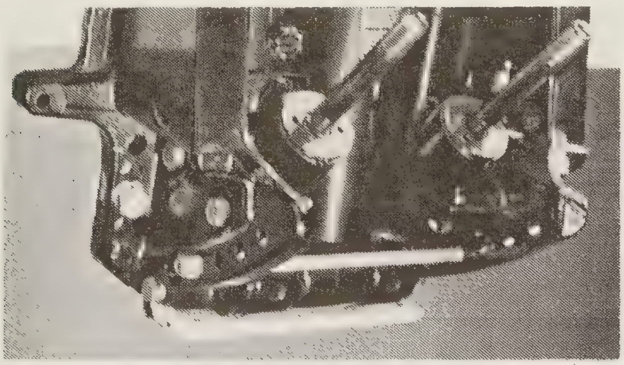
A Model 175hp outboard unit serviced and waiting for the owner to move the boat to a body of water for a FUN day with family and/or friends.



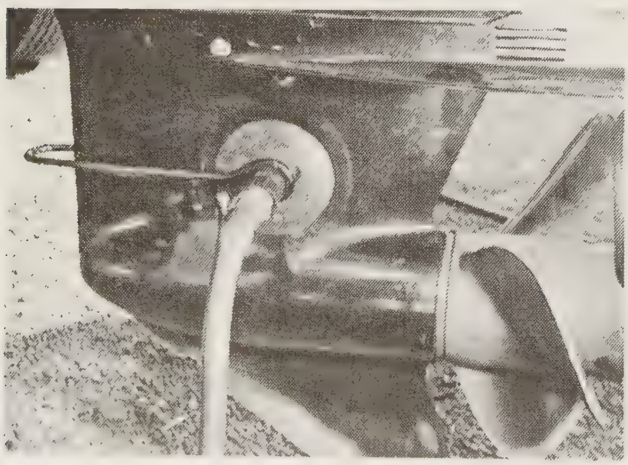
Zinc installation also used as the trim tab. The tab assists the helmsperson to maintain a true course without "fighting" the wheel.

Using Zinc

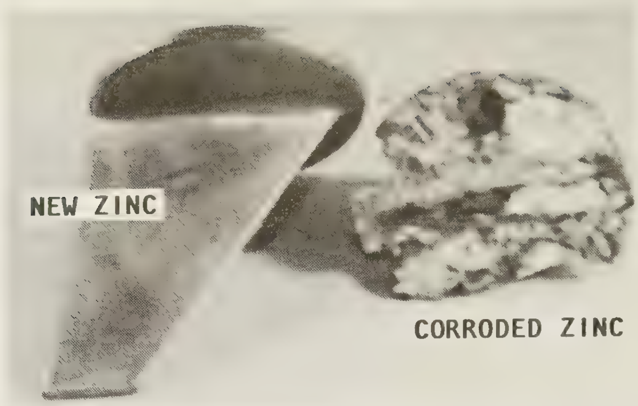
The proper amount of zinc attached to a boat is quite important. Using too small a zinc plate will cause more rapid deterioration of the metal intended to be protected. Obviously, it is far better to stand the cost a replacing a zinc than expensive metal parts.



A zinc plate attached to the underside of the transom bracket to protect expensive metal parts from corrosion.



Flush attachment and garden hose connected to the lower unit. The powerhead should never be operated above idle and the outboard should remain in ***NEUTRAL.***



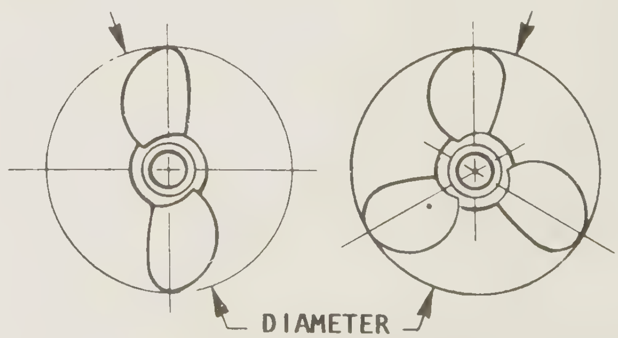
A new trim tab zinc, left, and a corroded zinc, right. An excellent example of the inexpensive zinc saving more costly parts of the outboard unit.

Through exhaustive testing, the manufacturer has determined two zincs will protect the outboard unit. The outboard units covered in this manual have a zinc plate attached to the underside of the transom bracket, as shown in the accompanying illustration.

Further protection is provided by a zinc trim tab. Therefore, the zinc remains with the lower unit at all times. The illustrations at the top of this page clearly indicate how this zinc can save the lower unit.

1-4 PROPELLERS

As you know, the propeller is actually what moves the boat through the water. This is how it is done. The propeller operates in water in much the manner as a wood screw does in wood. The propeller "bites" into the water as it rotates. Water passes between the blades and out to the rear in the shape of a cone. The propeller "biting" through the water in much the same manner as a wood auger is what propels the boat.



Diameter and pitch are the two basic dimensions of a propeller. The diameter is measured across the circumference of a circle scribed by the propeller blades, as shown.

Diameter and Pitch

Only two dimensions of the propeller are of real interest to the boat owner: the diameter and the pitch. These two dimensions are stamped on the propeller hub and always appear in the same order: the diameter first and then the pitch. For instance, the number 15-19 stamped on the hub, would mean the propeller had a diameter of 15 inches with a pitch of 19.

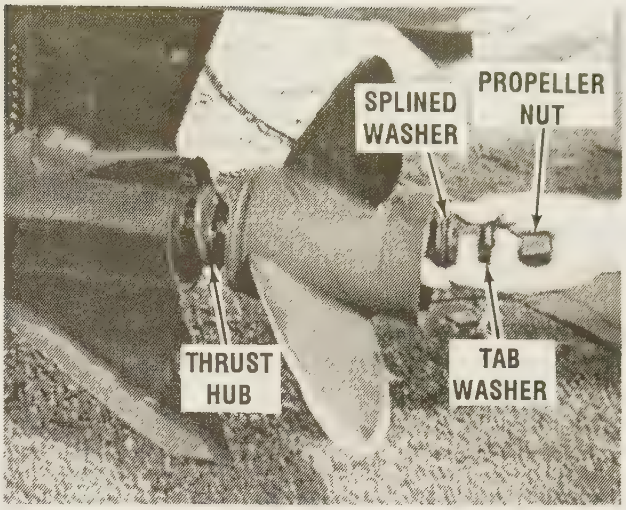
The diameter is the measured distance from the tip of one blade to the tip of the other as shown in the accompanying illustration.

The pitch of a propeller is the angle at which the blades are attached to the hub. This figure is expressed in inches of water travel for each revolution of the propeller. In our example of a 15-19 propeller, the propeller should travel 19 inches through the water each time it revolves. If the propeller action was perfect and there was no slippage, then the pitch multiplied by the propeller rpms would be the boat speed.

Most outboard manufacturers equip their units with a standard propeller with a diameter and pitch they consider to be best suited to the engine and the boat. Such a propeller allows the engine to run as near to the rated rpm and horsepower (at full throttle) as possible for the boat design.

The blade area of the propeller determines its load-carrying capacity. A two-blade propeller is used for high-speed running under very light loads.

A four-blade propeller is installed in boats intended to operate at low speeds under very heavy loads such as tugs, barges, or large houseboats. The three-blade propeller is the happy medium covering the wide range between the high performance units and the load carrying workhorses.



Typical propeller installation hardware for the lower units covered in this manual.

Propeller Selection

There is no standard propeller that will do the proper job in very many cases. The list of sizes and weights of boats is almost endless. This fact coupled with the many boat-engine combinations makes the propeller selection for a specific purpose a difficult job. In fact, in many cases the propeller is changed after a few test runs. Proper selection is aided through the use of charts set up for various engines and boats. These charts should be studied and understood when buying a propeller. However, bear in mind, the charts are based on average boats with average loads, therefore, it may be necessary to make a change in size or pitch, in order to obtain the desired results for the hull design or load condition.

Propellers are available with a wide range of pitch. Remember, a low pitch takes a smaller bite of the water than the high pitch propeller. This means the low pitch propeller will travel less distance through the water per revolution. The low

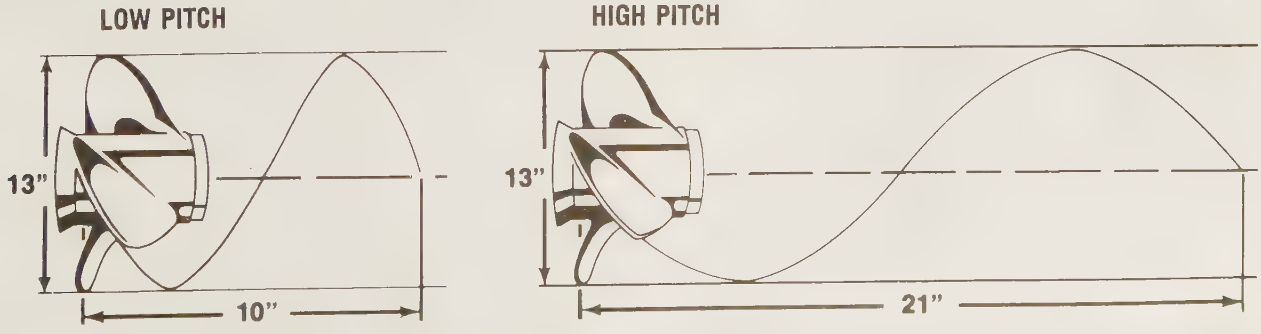


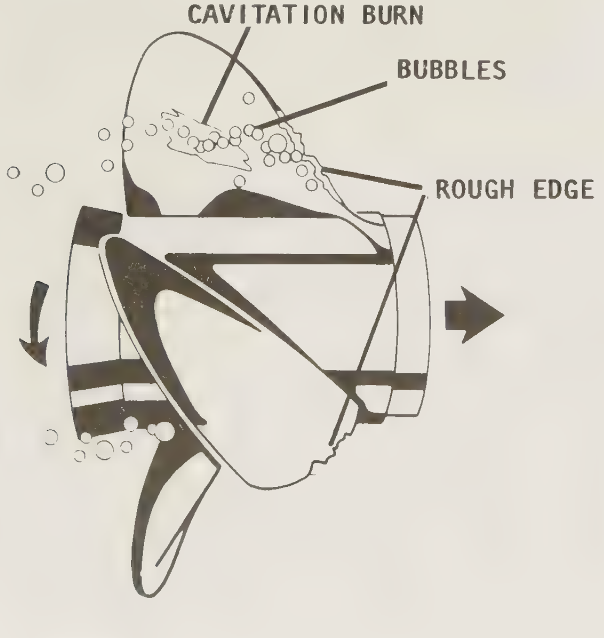
Diagram to explain the pitch dimension of a propeller. The pitch is the theoretical distance a propeller would travel through water if there were no friction.

pitch will require less horsepower and will allow the engine to run faster.

All engine manufacturers design their units to operate with full throttle at, or slightly above, the rated rpm. If you run your engine at the rated rpm, you will increase spark plug life, receive better fuel economy, and obtain the best performance from your boat and engine. Therefore, take time to make the proper propeller selection for the rated rpm of your engine at full throttle with what you consider to be an average load. Your boat will then be correctly balanced between engine and propeller throughout the entire speed range.

A reliable tachometer must be used to measure engine speed at full throttle to ensure the engine will achieve full horsepower and operate efficiently and safely. To test for the correct propeller, make your run in a body of smooth water with the lower unit in forward gear at full throttle. If the reading is above the manufacturer's recommended operating range, you must try propellers of greater pitch, until you find the one that allows the engine to operate continually within the recommended full throttle range.

If the engine is unable to deliver top performance and you feel it is properly tuned, then the propeller may not be to blame. Operating conditions have a marked effect on performance. For instance, an engine will lose rpm when run in very cold water. It will also lose rpm when run in salt water as compared with fresh water. A hot, low-barometer day will also cause your engine to lose power.



Cavitation (air bubbles) formed at the propeller. Manufacturers are constantly fighting this problem, as explained in the text.

Cavitation

Cavitation is the forming of voids in the water just ahead of the propeller blades. Marine propulsion designers are constantly fighting the battle against the formation of these voids due to excessive blade tip speed and engine wear. The voids may be filled with air or water vapor, or they may actually be a partial vacuum. Cavitation may be caused by installing a piece of equipment too close to the lower unit, such as the knot indicator pickup, depth sounder, or bait tank pickup.

Vibration

Your propeller should be checked regularly to be sure all blades are in good condition. If any of the blades become bent or nicked, this condition will set up vibrations in the drive unit and the motor. If the vibration becomes very serious it will cause a loss of power, efficiency, and boat performance. If the vibration is allowed to continue over a period of time it can have a damaging effect on many of the operating parts.

Vibration in boats can never be completely eliminated, but it can be reduced by keeping all parts in good working condition and through proper maintenance and lubrication. Vibration can also be reduced in

Example of a damaged propeller. This unit should have been replaced long before this amount of damage was sustained.

some cases by increasing the number of blades. For this reason, many racers use two-blade props and luxury cruisers have four- and five-blade props installed.

Shock Absorbers

The shock absorber in the propeller plays a very important role in protecting the shafting, gears, and engine against the shock of a blow, should the propeller strike an underwater object. The shock absorber allows the propeller to stop rotating at the instant of impact while the power train continues turning.

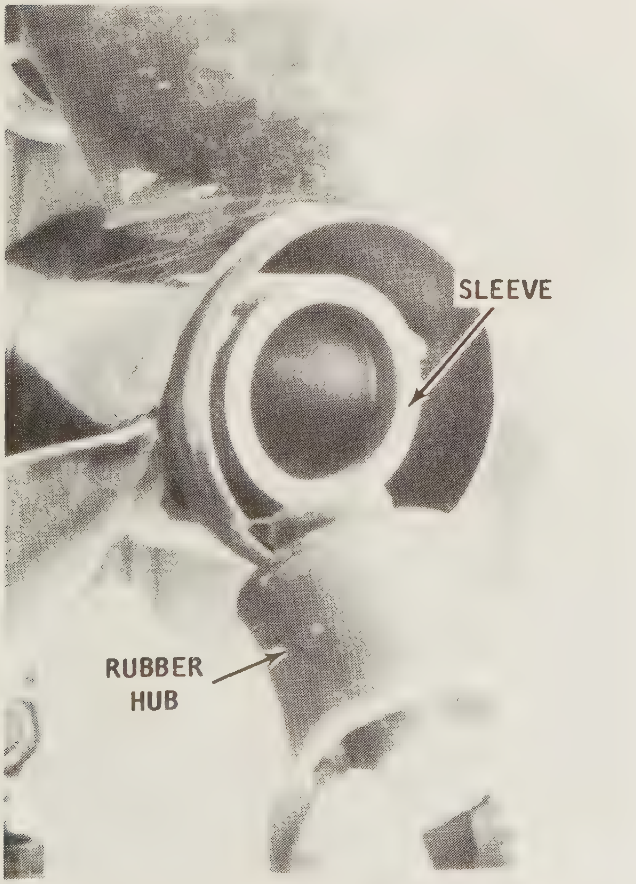
How much impact the propeller is able to withstand, before causing the shock absorber to slip, is calculated to be more than the force needed to propel the boat, but less than the amount that could damage any part of the power train. Under normal propulsion loads of moving the boat through the water, the hub will not slip. However, it will slip if the propeller strikes an object with a force that would be great enough to stop any part of the power train.

If the power train was to absorb an impact great enough to stop rotation, even for an instant, something would have to give and be damaged. If a propeller is subjected to repeated striking of underwater objects, it would eventually slip on its clutch hub under normal loads. If the propeller should start to slip, a new shock absorber/cushion hub would have to be installed.

Propeller Rake

If a propeller blade is examined on a cut extending directly through the center of the hub, and if the blade is set vertical to the propeller hub, as shown in the accompanying illustration, the propeller is said to have a zero degree (0°) rake. As the blade slants back, the rake increases. Standard propellers have a rake angle from 0° to 15°.

A higher rake angle generally improves propeller performance in a cavitating or ventilating situation. On lighter, faster boats, higher rake often will increase performance by holding the bow of the boat higher.



Rubber hub removed from the propeller because the hub was slipping in the propeller.

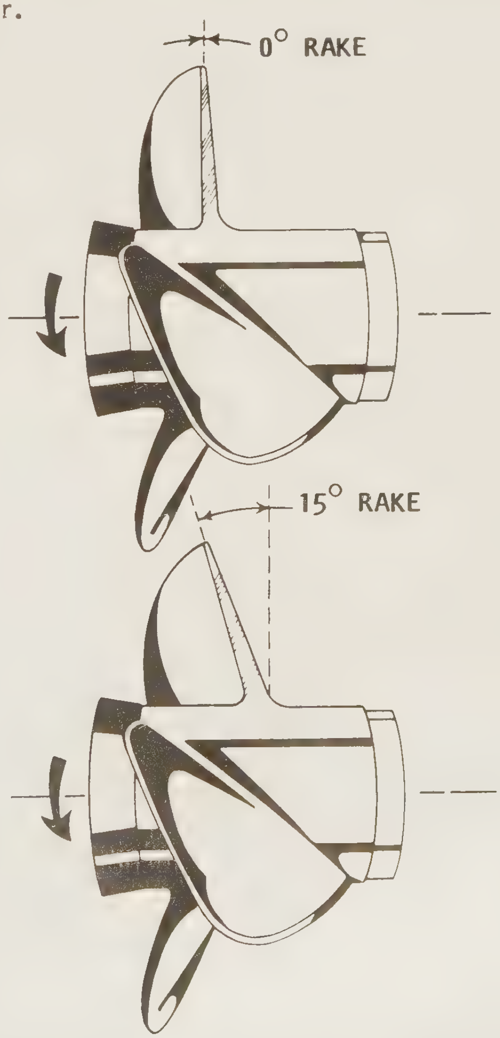
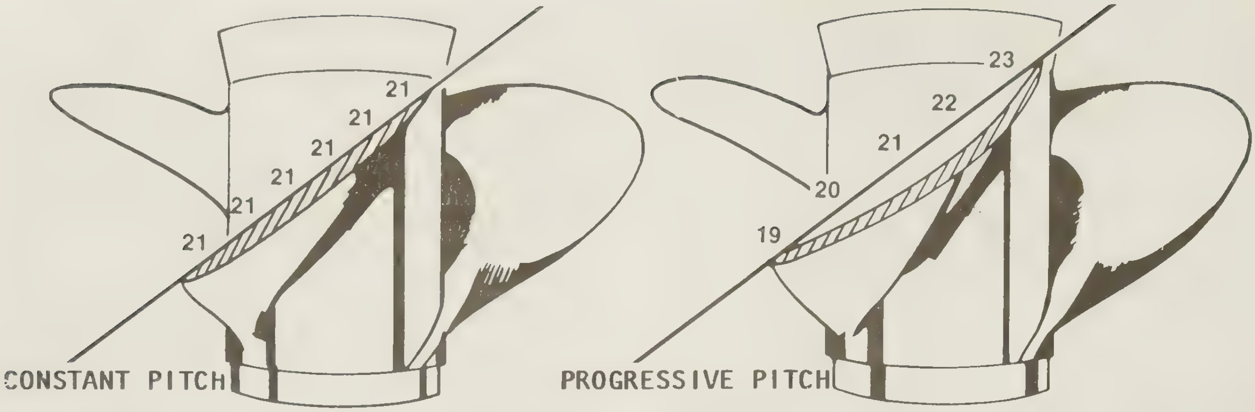


Illustration depicting the rake of a propeller, as explained in the text.



Comparison of a constant and progressive pitch propeller. Notice how the pitch of the progressive propeller, right, changes to give the blade more thrust and therefore, the boat more speed.

Progressive Pitch

Progressive pitch is a blade design innovation that improves performance when forward and rotational speed is high and/or the propeller breaks the surface of the water.

Progressive pitch starts low at the leading edge and progressively increases to the trailing edge, as shown in the accompanying illustration. The average pitch over the entire blade is the number assigned to that propeller. In the illustration of the progressive pitch, the average pitch assigned to the propeller would be 21.

Cupping

If the propeller is cast with an edge curl inward on the trailing edge, the blade is said to have a cup. In most cases, cupped blades improve performance. The cup helps the blades to **"HOLD"** and not break loose, when operating in a cavitating or ventilating situation.

The cup has the effect of adding to the propeller pitch. Cupping usually will reduce full-throttle engine speed about 150 to 300 rpm below the same pitch propeller without a cup to the blade. A propeller repair shop is able to increase or decrease the cup on the blades. This change, as explained, will alter engine rpm to meet specific operating demands. Cups are rapidly becoming standard on propellers.

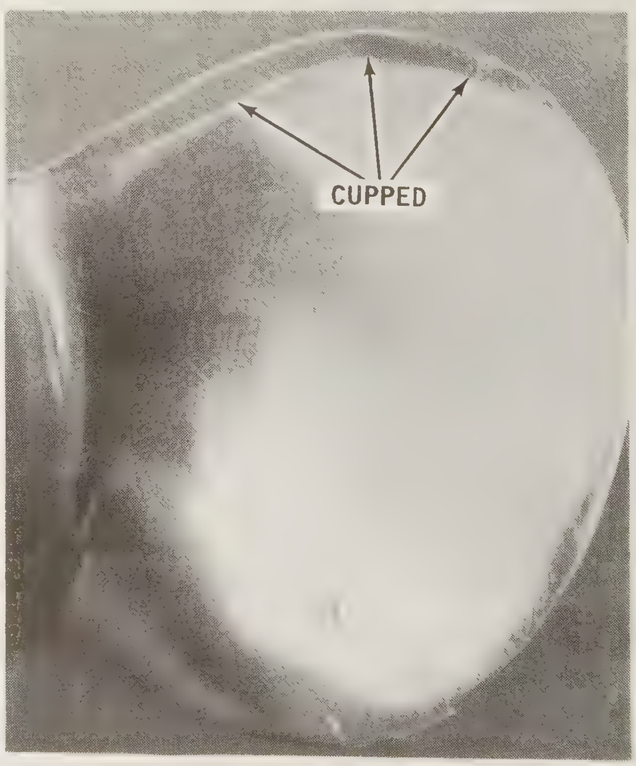
In order for a cup to be the most effective, the cup should be completely concave (hollowed) and finished with a sharp corner. If the cup has any convex rounding, the effectiveness of the cup will be reduced.

Rotation

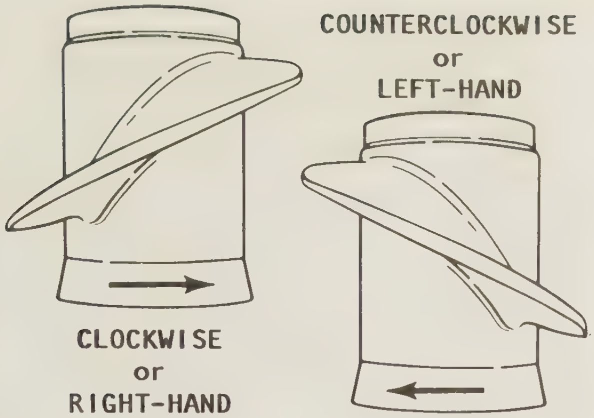
Propellers are manufactured as right-hand rotation (RH), and as left-hand rotation (LH). The standard propeller for outboard units is RH rotation.

A right-hand propeller can easily be identified by observing it as shown in the accompanying illustration. Observe how the blade of the right-hand propeller slants from the lower left to upper right. The left-hand propeller slants in the opposite direction, from lower right to upper left.

When the RH propeller is observed rotating from astern the boat, it will be rotating clockwise when the engine is in forward gear. The left-hand propeller will rotate counterclockwise.



Propeller with a "cupped" leading edge. "Cupping" gives the propeller a better "hold" in the water.

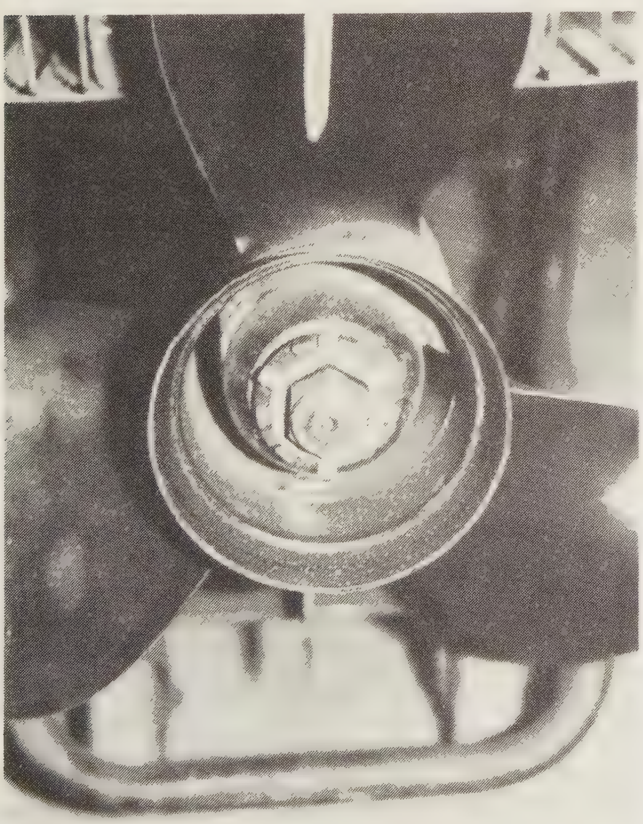


Right- and left-hand propellers showing how the angle of the blades is reversed. Right-hand propellers are by far the most popular for outboard units.

1-5 FUEL SYSTEM

With Built-in Fuel Tank

All parts of the fuel system should be selected and installed to provide maximum service and protection against leakage. Reinforced flexible sections should be installed in fuel lines where there is a lot of motion,



Typical propeller exhaust hub. This arrangement of exhaust gases passing through the hub results in a much quieter engine operation and the fumes are buried far behind the boat.

such as at the engine connection. The flaring of copper tubing should be annealed after it is formed as a protection against hardening.

CAUTION: Compression fittings should **NOT** be used because they are so easily overtightened, which places them under a strain and subjects them to fatigue. Such conditions will cause the fitting to leak after it is connected a second time.

The capacity of the fuel filter must be large enough to handle the demands of the engine as specified by the engine manufacturer.

A manually-operated valve should be installed if anti-siphon protection is not provided. This valve should be installed in the fuel line as close to the gas tank as possible. Such a valve will maintain anti-siphon protection between the tank and the engine.

The supporting surfaces and hold-downs must fasten the tank firmly and they should be insulated from the tank surfaces. This insulation material should be non-abrasive and nonabsorbent material. Fuel tanks installed in the forward portion of the boat should be especially well secured and protected because shock loads in this area can be as high as 20 to 25 g's ("g" equals force of gravity).

Taking On Fuel

The fuel tank of the boat should be kept full to prevent water from entering the system through condensation caused by temperature changes. Water droplets forming is one of the greatest enemies of the fuel system. By keeping the tank full, the air space in the tank is kept to an absolute minimum and there is no room for moisture to form. It is a good practice not to store

A three-position valve permits fuel to be drawn from either of two tanks or shut off completely. Such an arrangement prevents accidental siphoning of fuel from the tank. The inside diameter of the valve should be at 5/16" (7.94mm).

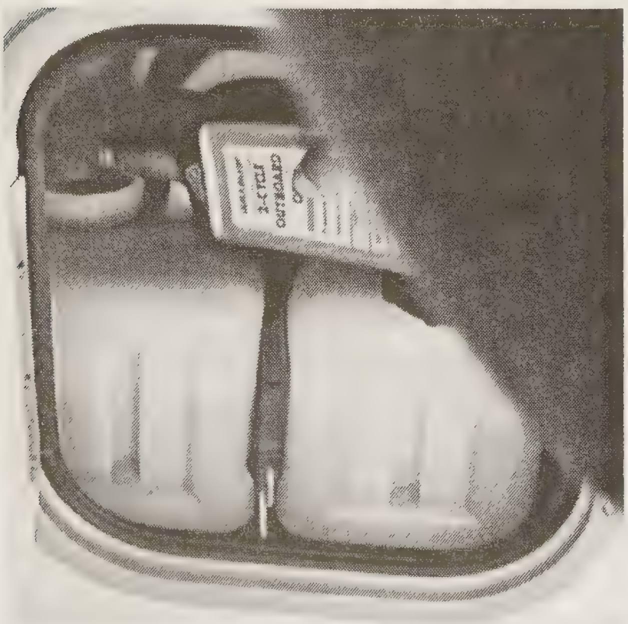
fuel in the tank over an extended period, say for six months. Today, fuels contain ingredients that change into gums when stored for any length of time. These gums and varnish products will cause carburetor problems and poor spark plug performance. An additive (Sta-Bil) is available and can be used to prevent gums and varnish from forming.

Static Electricity

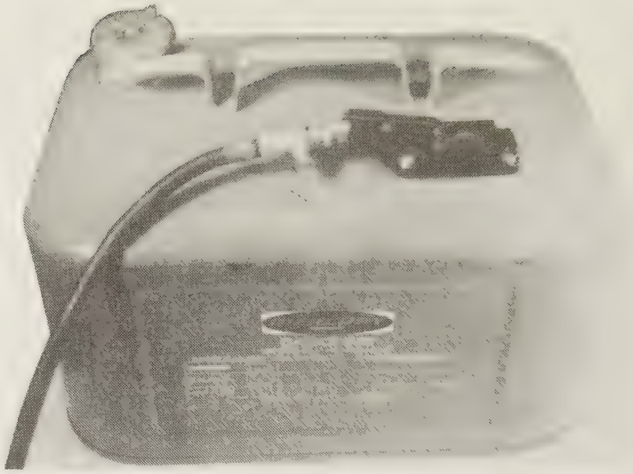
In very simple terms, static electricity is called frictional electricity. It is generated by two dissimilar materials moving over each other. One form is gasoline flowing through a pipe or into the air. Another form is when you brush your hair or walk across a synthetic carpet and then touch a metal object. All of these actions cause an electrical charge. In most cases, static electricity is generated during very dry weather conditions, but when you are filling the fuel tank on a boat it can happen at any time.

Fuel Tank Grounding

One area of protection against the build-up of static electricity is to have the fuel tank properly grounded (also known as bonding). A direct metal-to-metal contact from the fuel hose nozzle to the water in which



Adding approved oil to an oil tank installed under an aft seat against the transom. The oil is drawn from this tank to the small reservoir mounted on the powerhead before it is mixed with the fuel prior to entering the combustion chamber.



An approved fuel tank equipped with a quick-disconnect fitting. This type arrangement is handy when the tank must be removed from the boat to obtain fuel.

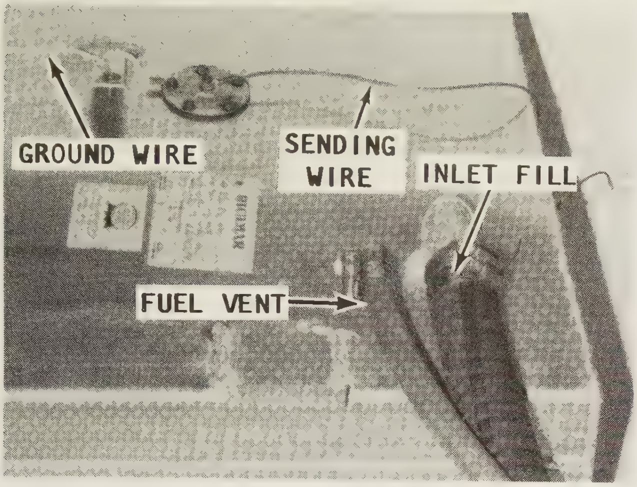
the boat is floating. If the fill pipe is made of metal, and the fuel nozzle makes a good contact with the deck plate, then a good ground is made.

As an economy measure, some boats use rubber or plastic filler pipes because of compound bends in the pipe. Such a fill line does not give any kind of ground and if your boat has this type of installation and you do not want to replace the filler pipe with a metal one, then it is possible to connect the deck fitting to the tank with a copper wire. The wire should be 8 gauge or larger.

The fuel line from the tank to the engine should provide a continuous metal-to-metal contact for proper grounding. If any part of this line is plastic or other non-metallic material, then a copper wire must be connected to bridge the non-metal material. The power train provides a ground through the engine and drive shaft, to the propeller in the water.

Fiberglass fuel tanks pose problems of their own. Fortunately, this material has almost totally disappeared as a suitable substance for fuel tanks. If, however, the boat you are servicing, does have a fiberglass tank, or one is being installed, or repaired, it is almost mandatory that you check with the Coast Guard Recreational Boating Standards Office in your district before proceeding with any work. The new standards are very specific and the Coast Guard is extremely rigid about enforcing the regulations.

Anything you can feel as a "shock" is enough to set off an explosion. Did you know that under certain atmospheric con-



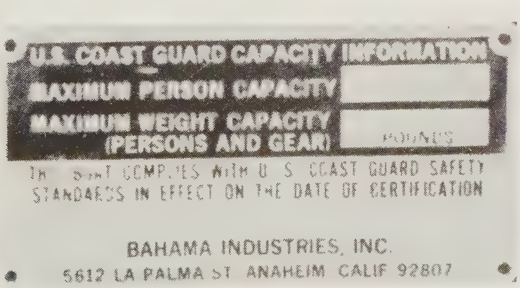
A fuel tank properly grounded to prevent static electricity. Static electricity could be extremely dangerous when taking on fuel.

ditions you can cause a static explosion yourself, particularly if you are wearing synthetic clothing. It is almost a certainty you could cause a static spark if you are **NOT** wearing insulated rubber-soled shoes.

As soon as the deck fitting is opened, fumes are released to the air. Therefore, to be safe you should ground yourself before opening the fill pipe deck fitting. One way to ground yourself is to dip your hand in the water overside to discharge the electricity in your body before opening the filler cap. Another method is to touch the engine block or any metal fitting on the dock which goes down into the water.

1-6 LOADING

In order to receive maximum enjoyment, with safety and performance, from your boat, take care not to exceed the load capacity given by the manufacturer. A plate attached to the hull indicates the U.S.



U.S. Coast Guard plate affixed to all new boats. When the blanks are filled in, the plate will indicate the Coast Guard's recommendations for persons, gear, and horsepower to ensure safe operation of the boat. These recommendations should not be exceeded, as explained in the text.

Coast Guard capacity information in pounds for persons and gear. If the plate states the maximum person capacity to be 750 pounds and you assume each person to weigh an average of 150 lbs., then the boat could carry five persons safely. If you add another 250 lbs. for motor and gear, and the maximum weight capacity for persons and gear is 1,000 lbs. or more, then the five persons and gear would be within the limit.

Try to load the boat evenly port and starboard. If you place more weight on one side than on the other, the boat will list to the heavy side and make steering difficult. You will also get better performance by placing heavy supplies aft of the center to keep the bow light for more efficient planing.

Clarification

Much confusion arises from the terms, certification, requirements, approval, regulations, etc. Perhaps the following may clarify a couple of these points.

1- The Coast Guard does not approve boats in the same manner as they "Approve" life jackets. The Coast Guard applies a formula to inform the public of what is safe for a particular craft.

2- If a boat has to meet a particular regulation, it must have a Coast Guard certification plate. The public has been led to believe this indicates approval of the Coast Guard. Not so.

3- The certification plate means a willingness of the manufacturer to meet the Coast Guard regulations for that particular craft. The manufacturer may recall a boat if it fails to meet the Coast Guard requirements.

4- The Coast Guard certification plate, see accompanying illustration, may or may not be metal. The plate is a regulation for the manufacturer. It is only a warning plate and the public does not have to adhere to the restrictions set forth on it. Again, the plate sets forth information as to the Coast Guard's opinion for safety on that particular boat.

5- Coast Guard Approved equipment is equipment which has been approved by the Commandant of the U.S. Coast Guard and has been determined to be in compliance with Coast Guard specifications and regulations relating to the materials, construction, and performance of such equipment.

1-7 HORSEPOWER

The maximum horsepower engine for each individual boat should not be increased by any great amount without checking requirements from the Coast Guard in your area. The Coast Guard determines horsepower requirements based on the length, beam, and depth of the hull. **TAKE CARE NOT** to exceed the maximum horsepower listed on the plate or the warranty, and possibly the insurance, on the boat may become void.

1-8 FLOTATION

If your boat is less than 20 ft. overall, a Coast Guard or BIA (Boating Industry of America), now changed to NMMA (National Marine Manufacturers Association), requirement is that the boat must have buoyant material built into the hull (usually foam) to keep it from sinking if it should become swamped. Coast Guard requirements are mandatory but the NMMA is voluntary.

"Kept from sinking" is defined as the ability of the flotation material to keep the boat from sinking when filled with water and with passengers clinging to the hull. One restriction is that the total weight of the motor, passengers, and equipment aboard does not exceed the maximum load capacity listed on the plate.

Type I PFD Coast Guard approved life jacket. This type flotation device provides the greatest amount of buoyancy. ***NEVER*** *use them for cushions or other purposes.*

Life Preservers —Personal Flotation Devices (PFDs)

The Coast Guard requires at least one Coast Guard approved life-saving device be carried on board all motorboats for each person on board. Devices approved are identified by a tag indicating Coast Guard approval. Such devices may be life preservers, buoyant vests, ring buoys, or buoyant cushions. Cushions used for seating are serviceable if air cannot be squeezed out of it. Once air is released when the cushion is squeezed, it is no longer fit as a flotation device. New foam cushions dipped in a rubberized material are almost indestructable.

Life preservers have been classified by the Coast Guard into five type categories. All PFDs presently acceptable on recreational boats fall into one of these five designations. All PFDs **MUST** be U.S. Coast Guard approved, in good and serviceable condition, and of an appropriate size for the persons who intend to wear them. Wearable PFDs **MUST** be readily accessible and throwable devices **MUST** be immediately available for use.

Type I PFD has the greatest required buoyancy and is designed to turn most **UNCONSCIOUS** persons in the water from a face down position to a vertical or slightly

A Type IV PFD cushion device intended to be thrown to a person in the water. If air can be squeezed out of the cushion, it is no longer fit for service as a PFD.

backward position. The adult size device provides a minimum buoyancy of 22 pounds and the child size provides a minimum buoyancy of 11 pounds. The Type I PFD provides the greatest protection to its wearer and is most effective for all waters and conditions.

Type II PFD is designed to turn its wearer in a vertical or slightly backward position in the water. The turning action is not as pronounced as with a Type I. The device will not turn as many different type persons under the same conditions as the Type I. An adult size device provides a minimum buoyancy of 15½ pounds, the medium child size provides a minimum of 11 pounds, and the infant and small child sizes provide a minimum buoyancy of 7 pounds.

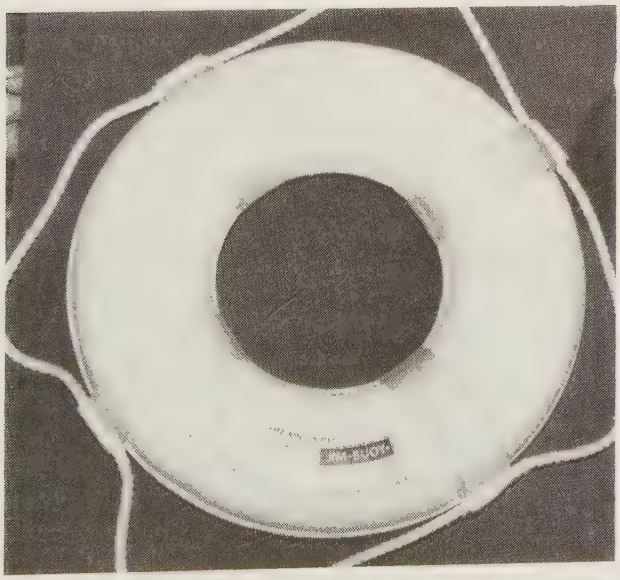
Type III PFD is designed to permit the wearer to place himself (herself) in a vertical or slightly backward position. The Type III device has the same buoyancy as the Type II PFD but it has little or no turning ability. Many of the Type III PFD are designed to be particularly useful when water skiing, sailing, hunting, fishing, or engaging in other water sports. Several of this type will also provide increased hypothermia protection.

Type IV PFD is designed to be thrown to a person in the water and grasped and held by the user until rescued. It is **NOT** designed to be worn. The most common Type IV PFD is a ring buoy or a buoyant cushion.

Type V PFD is any PFD approved for restricted use.

Coast Guard regulations state, in general terms, that on all boats less than 16 ft. overall, one Type I, II, III, or IV device shall be carried on board for each person in the boat. On boats over 26 ft., one Type I, II, or III device shall be carried on board for each person in the boat **plus** one Type IV device.

It is an accepted fact that most boating people own life preservers, but too few actually wear them. There is little or no excuse for not wearing one because the modern comfortable designs available today do not subtract from an individual's boating pleasure. Make a life jacket available to your crew and advise each member to wear it. If you are a crew member ask your skipper to issue you one, especially when boating in rough weather, cold water, or when running at high speed. Naturally, a life jacket should be a must for non-swimmers any time they are out on the water in a boat.



Type IV ring buoy also designed to be thrown to a person in the water. On ocean cruisers, this type device usually has a weighted pole with flag and light attached to the buoy.

Moisture-protected flares should be carried on board for use as a distress signal.

1-9 EMERGENCY EQUIPMENT

Visual Distress Signals
The Regulation

Since January 1, 1981, Coast Guard Regulations require all recreation boats when used on coastal waters, which includes the Great Lakes, the territorial seas and those waters directly connected to the Great Lakes and the territorial seas, up to a point where the waters are less than two miles wide, and boats owned in the United States, when operating on the high seas, to be equipped with visual distress signals.

The only exceptions are during daytime (sunrise to sunset) for:

Recreational boats less than 16 ft. (5 meters) in length.

Boats participating in organized events such as races, regattas or marine parades.

Open sailboats not equipped with propulsion machinery and less than 26 ft. (8 meters) in length.

Manually propelled boats.

The above listed boats need to carry night signals when used on these waters at night.

Pyrotechnic visual distress signaling devices **MUST** be Coast Guard Approved, in serviceable condition and stowed to be readily accessible. If they are marked with a

A sounding device should be mounted close to the helmsperson for use in sounding an emergency alarm.

date showing the serviceable life, this date must not have passed. Launchers, produced before Jan. 1, 1981, intended for use with approved signals are not required to be Coast Guard Approved.

USCG Approved pyrotechnic visual distress signals and associated devices include:

Pyrotechnic red flares, hand held or aerial.

Pyrotechnic orange smoke, hand held or floating.

Launchers for aerial red meteors or parachute flares.

Non-pyrotechnic visual distress signaling devices must carry the manufacturer's certification that they meet Coast Guard requirements. They must be in serviceable condition and stowed so as to be readily accessible.

This group includes:

Orange distress flag at least 3 x 3 feet with a black square and ball on an orange background.

Electric distress light -- not a flashlight but an approved electric distress light which **MUST** automatically flash the international **SOS** distress signal (. . . - - - . . .) four to six times each minute.

Types and Quantities

The following variety and combination of devices may be carried in order to meet the requirements.

1- Three hand-held red flares (day and night).

2- One electric distress light (night only).

3- One hand-held red flare and two parachute flares (day and night).

4- One hand-held orange smoke signal, two floating orange smoke signals (day) and one electric distress light (day and night).

If young children are frequently aboard your boat, careful selection and proper stowage of visual distress signals becomes especially important. If you elect to carry pyrotechnic devices, you should select those in tough packaging and not easy to ignite should the devices fall into the hands of children.

Coast Guard Approved pyrotechnic devices carry an expiration date. This date can **NOT** exceed 42 months from the date of manufacture and at such time the device can no longer be counted toward the minimum requirements.

SPECIAL WORDS

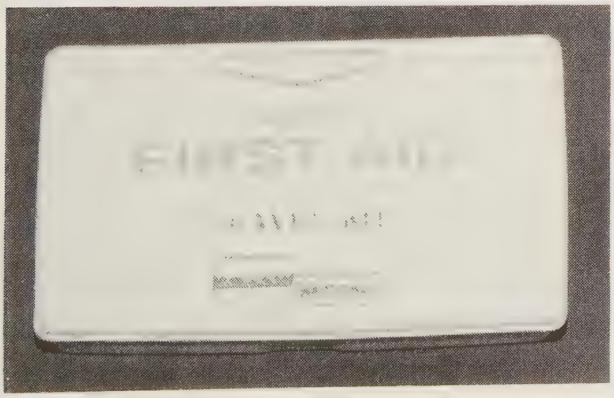
In some states the launchers for meteors and parachute flares may be considered a firearm. Therefore, check with your state authorities before acquiring such a launcher.

First Aid Kits

The first-aid kit is similar to an insurance policy or life jacket. You hope you don't have to use it but if needed, you want it there. It is only natural to overlook this essential item because, let's face it, who likes to think of unpleasantness when planning to have only a good time. However, the prudent skipper is prepared ahead of time, and is thus able to handle the emergency without a lot of fuss.

Good commercial first-aid kits are available such as the Johnson and Johnson "Marine First-Aid Kit". With a very modest expenditure, a well-stocked and adequate kit can be prepared at home.

Any kit should include instruments, supplies, and a set of instructions for their use. Instruments should be protected in a watertight case and should include: scissors, tweezers, tourniquet, thermometer, safety pins, eye-washing cup, and a hot water bottle. The supplies in the kit should include: assorted bandages in addition to the various sizes of "band-aids", adhesive tape, absorbent cotton, applicators, petroleum jelly, antiseptic (liquid and ointment), local ointment, aspirin, eye ointment, antihistamine, ammonia inhalent, sea-sickness pills, antacid pills, and a laxative. You may want to consult your family physician about including antibiotics. Be sure your kit contains a first-aid manual because even though you have taken the Red Cross course, you may be the patient and have to rely on an untrained crew for care.



An adequately stocked first aid kit should be on board for the safety of crew and guests.

Fire Extinguishers

All fire extinguishers must bear Underwriters Laboratory (UL) "Marine Type" approved labels. With the UL certification, the extinguisher does not have to have a Coast Guard approval number. The Coast Guard classifies fire extinguishers according to their size and type.

Type B-I or B-II Designed for extinguishing flammable liquids. Required on all motorboats.

The Coast Guard considers a boat having one or more of the following conditions as a "boat of closed construction" subject to fire extinguisher regulations.

1- Inboard engine or engines.

2- Closed compartments under thwarts and seats wherein portable fuel tanks may be stored.

3- Double bottoms not sealed to the hull or which are not completely filled with flotation materials.

4- Closed living spaces.

5- Closed stowage compartments in which combustible or flammable material is stored.

6- Permanently installed fuel tanks.

Detailed classification of fire extinguishers is by agent and size:

A suitable fire extinguisher should be mounted close to the helmsperson for emergency use.

B-I contains 1-1/4 gallons foam, 4 pounds carbon dioxide, 2 pounds dry chemical, and 2-1/2 pounds freon.

B-II contains 2-1/2 gallons foam, 15 pounds carbon dioxide, and 10 pounds dry chemical.

The class of motorboat dictates how many fire extinguishers are required on board. One B-II unit can be substituted for two B-I extinguishers.

Dry chemical fire extinguishers without gauges or indicating devices must be weighed and tagged every 6 months. If the gross weight of a carbon dioxide (CO_2) fire extinguisher is reduced by more than 10% of the net weight, the extinguisher is not acceptable and must be recharged.

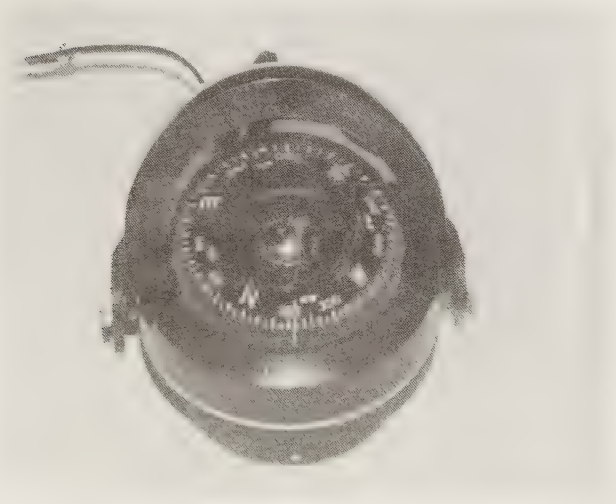
READ labels on fire extinguishers. If the extinguisher is U.L. listed, it is approved for marine use.

DOUBLE the number of fire extinguishers recommended by the Coast Guard, because their requirements are a bare **MINIMUM** for safe operation. Your boat, family, and crew, must certainly be worth much more than "bare minimum".

1-10 COMPASS

Selection

The safety of the boat and her crew may depend on her compass. In many areas weather conditions can change so rapidly that within minutes a skipper may find himself "socked-in" by a fog bank, a rain squall, or just poor visibility. Under these conditions, he may have no other means of keeping to his desired course except with the compass. When crossing an open body of water, his compass may be the only means of making an accurate landfall.



Do not hesitate to spend a few extra dollars for a good, reliable compass. If in doubt, seek advice from fellow boaters.

During thick weather when you can neither see nor hear the expected aids to navigation, attempting to run out the time on a given course can disrupt the pleasure of the cruise. The skipper gains little comfort in a chain of soundings that does not match those given on the chart for the expected area. Any stranding, even for a short time, can be an unnerving experience.

A pilot will not knowingly accept a cheap parachute. A good boater should not accept a bargain in lifejackets, fire extinguishers, or compass. Take the time and spend the few extra dollars to purchase a compass to fit your expected needs. Regardless of what the salesman may tell you, postpone buying until you have had the chance to check more than one make and model.

Lift each compass, tilt and turn it, simulating expected motions of the boat. The compass card should have a smooth and stable reaction.

The card of a good quality compass will come to rest without oscillations about the lubber's line. Reasonable movement in your hand, comparable to the rolling and pitching of the boat, should not materially affect the reading.

Installation

Proper installation of the compass does not happen by accident. Make a critical check of the proposed location to be sure compass placement will permit the helmsman to use it with comfort and accuracy. First, the compass should be placed directly in front of the helmsman and in such a position that it can be viewed without body stress as he sits or stands in a posture of relaxed alertness. The compass should be in the helmsman's zone of comfort. If the compass is too far away, he may have to bend forward to watch it; too close and he must rear backward for relief.

Second, give some thought to comfort in heavy weather and poor visibilty conditions during the day and night. In some cases, the compass position may be partially determined by the location of the wheel, shift lever, and throttle handle.

Third, inspect the compass site to be sure the instrument will be at least two feet

from any engine indicators, bilge vapor detectors, magnetic instruments, or any steel or iron objects. If the compass cannot be placed at least two feet (six feet would be better) from one of these influences, then either the compass or the other object must be moved, if first order accuracy is to be expected.

Once the compass location appears to be satisfactory, give the compass a test before installation. Hidden influences may be concealed under the cabin top, forward of the cabin aft bulkhead, within the cockpit ceiling, or in a wood-covered stanchion.

Move the compass around in the area of the proposed location. Keep an eye on the card. A magnetic influence is the only thing that will make the card turn. You can quickly find any such influence with the compass. If the influence can not be moved away or replaced by one of non-magnetic material, test to determine whether it is merely magnetic, a small piece of iron or steel, or some magnetized steel. Bring the north pole of the compass near the object, then shift and bring the south pole near it. Both the north and south poles will be attracted if the compass is demagnetized. If the object attracts one pole and repels the other, then the compass is magnetized. If your compass needs to be demagnetized, take it to a shop equipped to do the job **PROPERLY.**

After the compass has been moved around in the proposed area, hold it down and tape it in position. Test everything which might affect the compass and cause a deviation from a true reading. Rotate the wheel from hard over to hard over. Switch on and off all the lights, radios, radio direction finder, radio telephone, depth finder and the shipboard intercom, if one is installed. Sound the electric whistle, turn on the windshield wipers, start the engine (with water circulating through the engine), work the throttle, and move the gear shift lever. If the boat has an auxiliary generator, start it.

If the compass card moves during any one of these tests, the compass should be relocated, Naturally, if something like the windshield wipers causes a slight deviation, it may be necessary to make a different deviation table to use only when certain pieces of equipment are operating. Bear in mind, following a course only one or two degrees off for several hours can make considerable difference at the end, putting the boat on a reef, rock, or shoal.

Check to be sure the intended compass site is solid. Vibration will increase pivot wear.

Now, you are ready to mount the compass. To prevent an error on all courses, the line through the lubber line and the compass card pivot must be exactly parallel to the keel of the boat. You can establish the fore-and-aft line of the boat with a stout cord or string. Use care to transfer this line to the compass site. If necessary, shim the base of the compass until the stile-type lubber line (the one affixed to the case and not gimbaled) is vertical when the boat is on an even keel. Drill the holes and mount the compass.

Magnetic Items After Installation

Many times an owner will install an expensive stereo system in the cabin of his boat. It is not uncommon for the speakers to be mounted on the aft bulkhead up against the overhead (ceiling). In almost every case, this position places one of the speakers in very close proximity to the compass, mounted above the ceiling.

As we all know, a magnet is used in the operation of the speaker. Therefore, it is very likely that the speaker, mounted almost under the compass in the cabin will have a very pronounced affect on the compass accuracy.

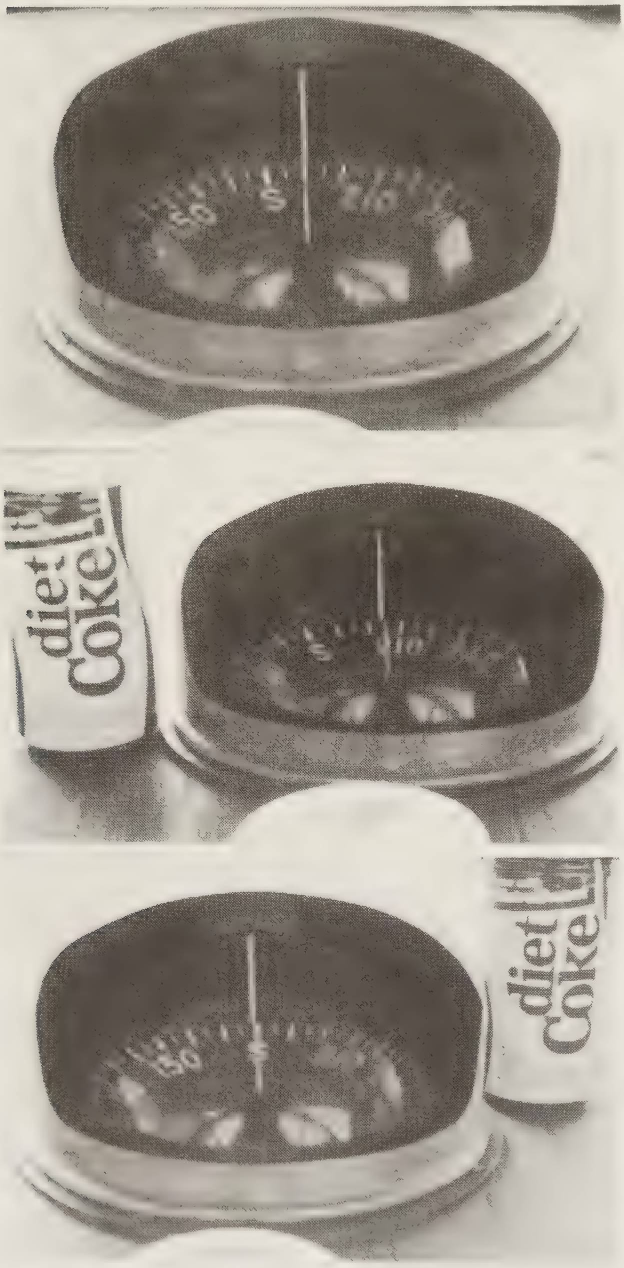
The compass is a delicate instrument and deserves respect. It should be mounted securely and in a position where it can be easily observed by the helmsperson.

Consider the following test and the accompanying photographs as proof of the statements made.

First, the compass was read as 190 degrees while the boat was secured in her slip.

Next, a full can of diet coke in an **ALUMINUM** can was placed on one side of the compass and the compass was then read as 204 degrees, a good 14 degrees difference from the first reading.

The full can was then moved to the opposite side of the compass and again a reading was observed. This time the reading was 189 degrees -- 11 degrees difference from the original reading.



"Innocent" objects close to the compass, such as diet coke in an aluminum can, may cause serious problems and lead to disaster, as these three photos and the accompanying text prove.

Finally the contents of the can were consumed, the can placed on both sides of the compass with **NO** affect on the compass reading.

Two very important conclusions can be drawn from these tests.

1- Something must have been in the contents of the can to affect the compass so drastically.

2- Keep even "innocent" things clear of the compass to avoid any possible error in the boat's heading.

REMEMBER, a boat moving through the water at 10 knots on a compass error of just 5 degrees will be almost 1.5 miles off course in only **ONE** hour. At night, or in thick weather, this could very possibly put the boat on a reef, rock, or shoal, with disastrous results.

1-11 STEERING

USCG and NMMA certification of a steering system means all materials, equipment, and installation of the steering parts meet or exceed specific standards for strength, type, and maneuverability. Service procedures for the power steering system which may be installed as optional equipment are given in Chapter 8.

1-12 ANCHORS

One of the most important pieces of equipment in the boat next to the power plant is the ground tackle carried. The engine makes the boat go and the anchor and its line are what hold it in place when the boat is not secured to a dock or on the beach.

The anchor must be of suitable size, type, and weight to give the skipper "peace of mind" when the boat is at anchor. Under certain conditions, a second, smaller, lighter anchor may help to keep the boat in a favorable position during a non-emergency daytime situation.

In order for the anchor to hold properly, a piece of chain must be attached to the anchor and then the nylon anchor line attached to the chain. The amount of chain should equal or exceed the length of the boat. Such a piece of chain will ensure that the anchor stock will lay in an approximate horizontal position and permit the flutes to dig into the bottom and hold.

1-13 MISCELLANEOUS EQUIPMENT

In addition to the equipment you are legally required to carry in the boat and those previously mentioned, some extra items will add to your boating pleasure and safety. Practical suggestions would include: a bailing device (bucket, pump, etc.), boat hook, fenders, spare propeller, spare engine parts, tools, an auxiliary means of propulsion (paddle or oars), spare can of gasoline, flashlight, and extra warm clothing. The area of your boating activity, weather conditions, length of stay aboard your boat, and the specific purpose will all contribute to the kind and amount of stores you put aboard. When it comes to personal gear, heed the advice of veteran boaters who say, "Decide on how little you think you can get by with, then cut it in half".

Bilge Pumps

Automatic bilge pumps should be equipped with an overriding manual switch. They should also have an indicator in the operator's position to advise the helmsman when the pump is operating. Select a pump that will stabilize its temperature within the manufacturer's specified limits when it is operated continuously. The pump motor should be a sealed or arcless type, suitable for a marine atmosphere. Place the bilge pump inlets so excess bilge water can be removed at all normal boat trims. The intakes should be properly screened to prevent the pump from sucking up debris from the bilge. Intake tubing should be of a high quality and stiff enough to resist kinking and not collapse under maximum pump suction condition if the intake becomes blocked.

To test operation of the bilge pump, operate the pump switch. If the motor does not run, disconnect the leads to the motor. Connect a voltmeter to the leads and see if voltage is indicated. If voltage is not indicated, then the problem must be in a blown fuse, defective switch, or some other area of the electrical system.

If the meter indicates voltage is present at the leads, then remove, disassemble, and inspect the bilge pump. Clean it, reassemble, connect the leads, and operate the switch again. If the motor still fails to run, the pump must be replaced.

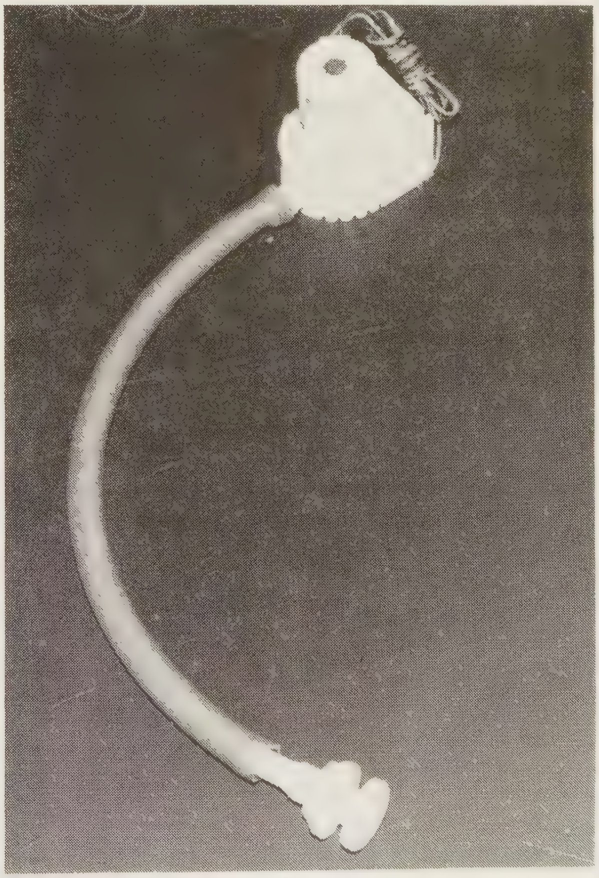
To test the bilge pump switch, first disconnect the leads from the pump and connect them to a test light.

Next, hold the switch firmly against the mounting location in order to make a good ground. Now, tilt the opposite end of the switch upward until it is activated as indicated by the test light coming on or the ohmmeter showing continuity. Finally, lower the switch slowly toward the mounting position until it is deactivated. Measure the distance between the point the switch was activated and the point it was deactivated. For proper service, the switch should deactivate between 1/2-inch and 1/4-inch from the planned mounting position. **CAUTION: The switch must never be mounted lower than the bilge pump pickup.**

1-14 BOATING ACCIDENT REPORTS

In the United States, new federal and state regulations require an accident report to be filed with the nearest state boating authority within 48 hours, if a person is lost, disappears, or is injured. "Injured" is defined as requiring medical attention beyond "First Aid".

Accidents involving only property or equipment damage **MUST** be reported within



The bilge pump line must be cleaned frequently to ensure the bilge pump will be able to do its job in an emergency.

10 days if the damage is in excess of $200. Some states are more stringent and require reporting of accidents with property damage less than $200.

A **$500 PENALTY** may be assessed for failure to submit the report.

WORD OF ADVICE

Take time to make a copy of the report to keep for your records or for the insurance company. Once the report is filed, the Coast Guard will not give out a copy, even to the person who filed the report.

The report must give details of the accident and include:

1- The date, time, and exact location of the occurrence.

2- The name of each person who died, was lost, or injured.

3- The number and name of the vessel.

4- The names and addresses of the owner and operator.

If the operator cannot file the report for any reason, each person on board **MUST** notify the authorities, or determine that the report has been filed.

1-15 NAVIGATION

Buoys

In the United States, a buoyage system is used as an assist to all boaters of all size craft to navigate our coastal waters and our navigable rivers in safety. When properly read and understood, these buoys and markers will permit the boater to cruise with comparative confidence that he will be able to avoid reefs, rocks, shoals, and other hazards.

In the spring of 1983, the Coast Guard began making modifications to U.S. aids to navigation in support of an agreement sponsored by the International Associaiton of Lighthouse Authorities (IALA) and signed by representatives from most of the maritime nations of the world. The primary purpose of the modifications is to improve safety by making buoyage systems around the world more alike and less confusing.

In nautical terms, the front of the boat is the **bow**; the rear is the **stern.**

The terms **"PORT"** and **"STARBOARD"** are used to refer to the left and right side of the boat, when looking forward. One easy way to remember this basic fundamental is to consider the words "port" and "left" both have four letters and go together.

Waterway Rules

On the water, certain basic safe-operating practices must be followed. You should learn and practice them, for to **know**, is to be able to handle your boat with confidence and safety. Knowledge of what to do, and not do, will add a great deal to the enjoyment you will receive from your boating investment.

Rules of the Road

The best advice possible and a Coast Guard requirement for boats over 39' 4" (12 meters) since 1981, is to obtain an official copy of the "Rules of the Road", which includes Inland Waterways, Western Rivers, and the Great Lakes for study and ready reference.

The following two paragraphs give a **VERY** brief, condensed, and abbreviated -- synopsis of the rules. They should not be considered in any way as covering the entire subject.

Powered boats must yield the right-of-way to all boats without motors, except when being overtaken. When meeting another boat head-on, keep to starboard, unless you are too far to port to make this practical. When overtaking another boat, the right-of-way belongs to the boat being overtaken. If your boat is being passed, you must maintain course and speed.

When two boats approach at an angle and there is danger of collision, the boat to port must give way to the boat to starboard. Always keep to starboard in a narrow channel or canal. Boats underway must stay clear of vessels fishing with nets, lines, or trawls. (Fishing boats are not allowed to fish in channels or to obstruct navigation.)

2
TUNING

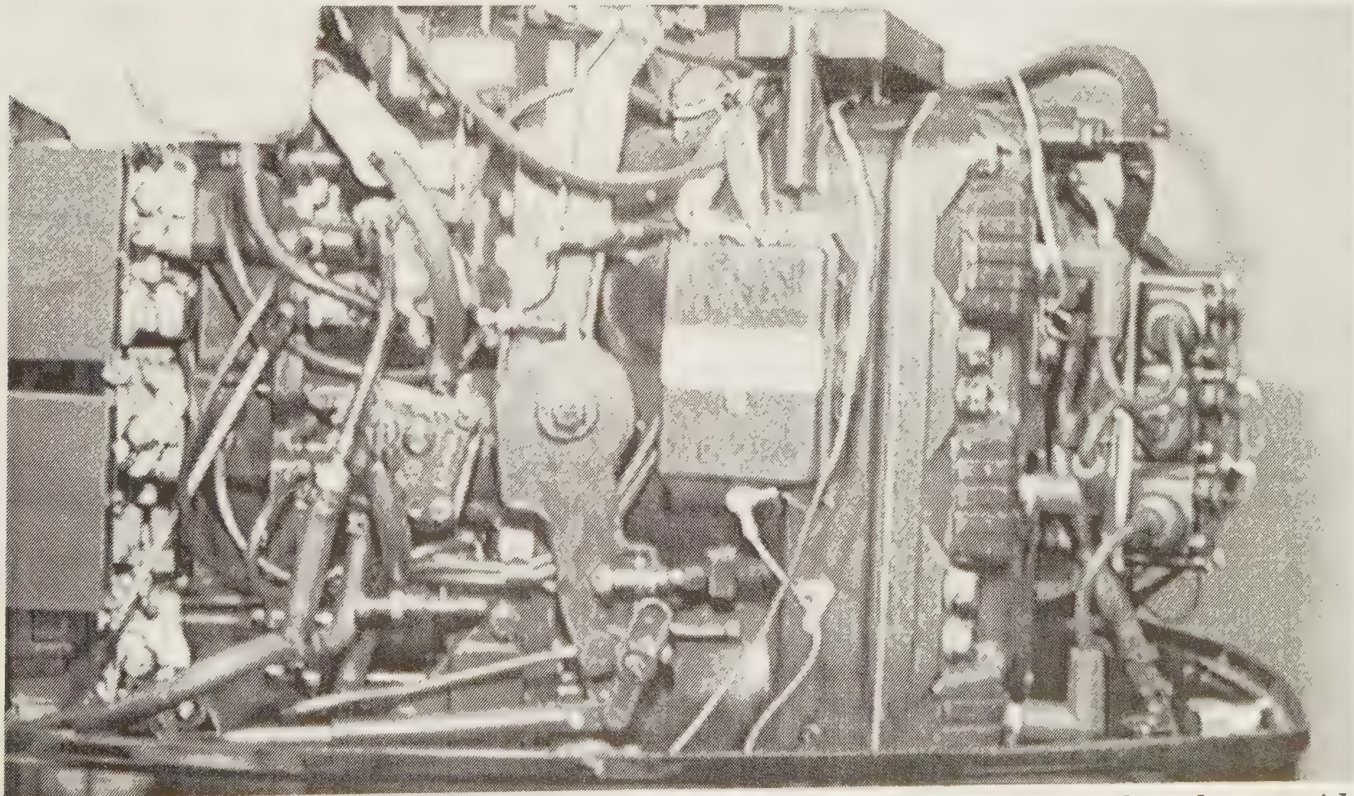
2-1 INTRODUCTION

The efficiency, reliability, fuel economy and enjoyment available from powerhead performance are all directly dependent on having it properly tuned. The importance of performing service work in the sequence detailed in this chapter cannot be over emphasized. Before making any adjustments, check the specifications in the Appendix. **NEVER** rely on memory when making critical adjustments.

Before beginning to tune any powerhead, check to be sure the powerhead has satisfactory compression. A powerhead with worn or broken piston rings, burned pistons, or scored cylinder walls, cannot be made to perform properly no matter how much time and expense is spent on the tune-up. Poor compression must be corrected or the tune-up will not give the desired results.

A practical maintenance program followed throughout the year, is one of the best methods of ensuring the complete unit will give satisfactory performance at any time.

The extent of the outboard tune-up is usually dependent on the time lapse since the last service. A complete tune-up of the entire outboard unit would entail almost all the work outlined in this manual. A logical sequence of steps will be presented in general terms. If additional information or detailed service work is required, the chapter containing the instructions will be referenced.



Once the powerhead cowling is removed, tuning adjustments are exposed on the port side. Adjustment procedures and locations are clearly explained and shown in this chapter.

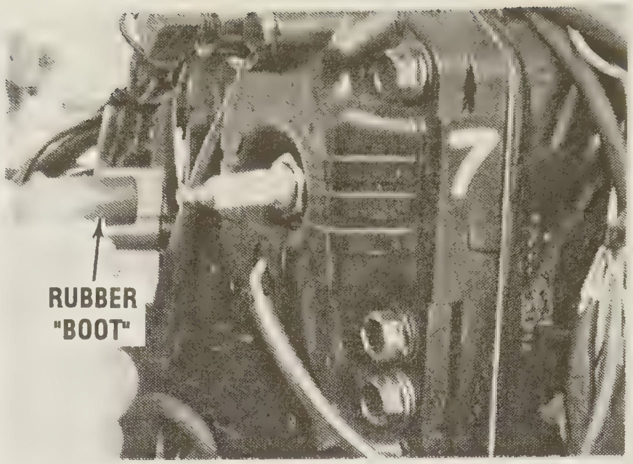
Each year higher compression ratios are built into modern outboard powerheads and the electrical systems become more complex, especially with the electronic capacitor discharge (CD), ignition system and the electronic fuel injection (EFI), systems. Therefore, the need for reliable, authoritative, and detailed instructions becomes more critical. The information in this chapter and the referenced chapters fulfill such a requirement.

2-2 TUNE-UP SEQUENCE

During a major tune-up, a definite sequence of service work should be followed to return the outboard to the maximum performance desired. This type work should not be confused with attempting to locate problem areas of "why" the unit is not performing satisfactorily. This work is classified as "troubleshooting". In many cases, these two areas will overlap. A minor or major tune-up may correct the malfunction and return the system to normal operation.

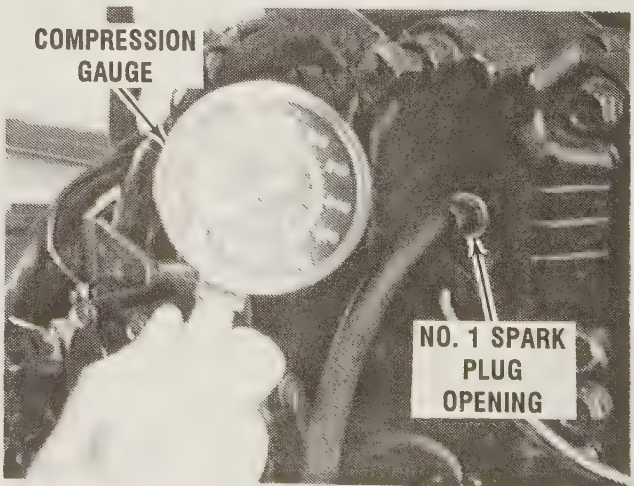
The following list is a suggested sequence of tasks to perform during the tune-up service work. The tasks are merely listed here. Generally procedures are given in subsequent sections of this chapter. For more detailed instructions, see the referenced chapter.

A boat and lower unit covered with marine growth. Such a condition is a serious hinderance to performance and cannot be corrected by tuning the powerhead.



***ALWAYS** use a pulling and twisting motion only on the "boot" when removing spark plug high tension leads.*

1- Perform a compression check of each cylinder. See next page -- this chapter.
2- Inspect the spark plugs to determine their condition. Test for adequate spark at each plug.
3- Start the powerhead with the outboard in a body of water or with a flush attachment connected to the lower unit. Check the water flow through the powerhead by observing the "tattle tale" stream. See Chapter 9.
4- Check the gear oil in the lower unit. See Chapter 9.
5- Check the carburetor adjustments and the need for a carburetor overhaul. See Chapter 4.
6- Check the fuel pump and the oil injection pump for adequate performance and delivery. See Chapter 4.



A hose fitting on a compression gauge threaded into the No. 1 spark plug opening in preparation to making a compression check. All cylinders must be tested.

7- Make a general inspection of the ignition system. See Chapter 5.

8- Check, charge or change the battery.

9- Test the cranking motor and the solenoid. See Chapter 7.

10- Check the timing and synchronization. See Chapter 6.

11- Check the fluid level in the power trim and tilt system. See Chapter 10.

2-3 COMPRESSION CHECK

A compression check is extremely important, because a powerhead with low or uneven compression between cylinders **CANNOT** be tuned to operate satisfactorily. Therefore, it is essential for any compression problem to be corrected before proceeding with the tune-up procedure.

If the powerhead shows any indication of overheating, such as discolored or scorched paint, inspect the cylinders visually thru the transfer or exhaust ports for possible scoring. It is possible for a cylinder with satisfactory compression to be scored slightly. Also, check the water pump. The overheating condition may be caused by a faulty water pump or defective thermostat.

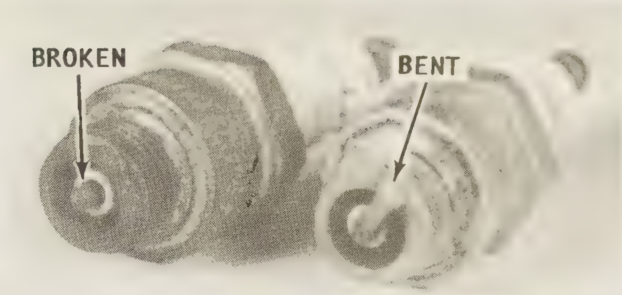
Checking Compression

Remove the spark plug high tension leads. **ALWAYS** grasp the molded cap and pull it free of the plug with a twisting motion, to prevent damage to the connection. Remove the spark plugs and keep them in **ORDER** by cylinder for evaluation later. Ground the spark plug leads to the powerhead or place the Emergency Stop switch -- on the remote control -- to the **ON** position. This action will render the ignition system inoperative while performing the compression check.

Insert a compression gauge into the No. 1 spark plug opening. Crank the powerhead with the cranking motor through at least four complete rotations of the crankshaft with the throttle at the **WIDE OPEN** position -- to obtain the highest possible reading. Record the highest reading.

HELPFUL WORDS

The manufacturer does not give a specific figure for compression for any of the model powerheads produced. However, it might be safe to say -- the compression should be in the neighborhood of 125 psi for the powerheads covered in this manual.



*Damaged spark plugs. Notice the broken electrode on the left plug. The broken part **MUST** be found and removed before returning the engine to service.*

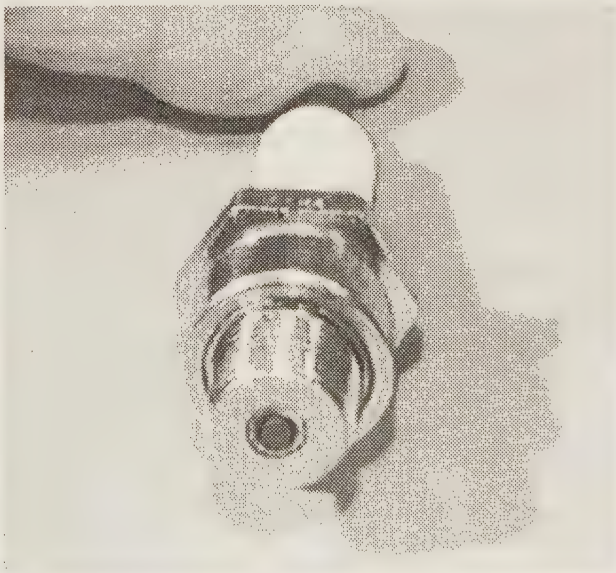
Repeat the test and record the compression for each cylinder. A variation between cylinders is far more important than the actual reading. A variation of more than -- say -- 15 psi between cylinders indicates the lower compression cylinder is defective. The problem may be worn, broken, or sticking piston rings, scored pistons or worn cylinders.

Use of an engine cleaner -- such as the one shown in the illustration on the next page -- will help to free stuck rings and dissolve accumulated carbon. When using such a product, follow the manufacturer's directions on the container.

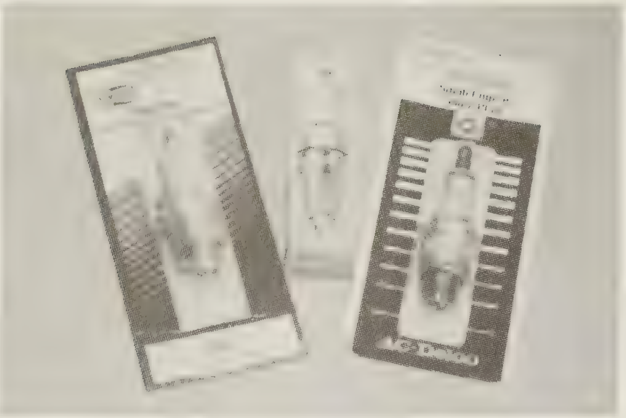
2-4 SPARK PLUG INSPECTION

Inspect each spark plug for badly worn electrodes, glazed, broken, blistered, or oil fouled insulators. Replace all plugs, if any one shows signs of excessive wear or heat damage.

Make an evaluation of cylinder performance by comparing the spark plug condition with



Example of a non-adjustable surface gap spark plug operated under favorable conditions.



Today, several type spark plugs are available for service on a marine two-stroke powerhead. ***ALWAYS*** *check with the local marine dealer to be sure the proper plug is purchased for the powerhead being serviced.*

those shown in Chapter 5. Check each spark plug to be sure they are all from the same manufacturer and all have the same heat range rating.

Inspect the threads in the spark plug opening in the block, and clean the threads before installing the plug.

ALWAYS ask the marine dealer if there has been a spark plug change for the powerhead being serviced.

Before the spark plugs are installed, crank the powerhead through several revolutions to blow out any material which might have become dislodged during the thread cleaning process.

Install the spark plugs and tighten them to a torque value of 21 ft lbs (28.5Nm). Wipe the

Use of an engine cleaner, such as the Quicksilver product shown, will help to free stuck rings and dissolve accumulated carbon. Follow directions on the container.

seat in the block clean and **ALWAYS** install a **NEW** gasket -- if a gasket is used with the plug, as evidenced by the plug having a "square" seat. A plug with a tapered seat will **NOT** use a gasket. The gasket must be fully compressed on clean seats to complete the heat transfer process and to provide a tight seal for the compressed fuel/air mixture in the cylinder.

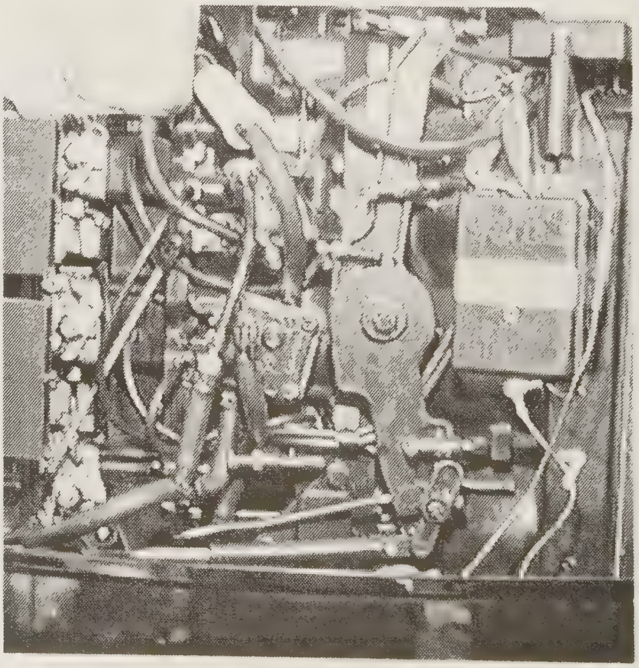
If either type plug is not tightened to the full torque value, the transfer of heat will be too slow.

2-5 IGNITION SYSTEM

A capacitor discharge -- commonly abbreviated in the trade as simply "CD" -- ignition system is used on the outboard powerheads covered in this manual. If powerhead performance is less than expected, and the ignition system is suspected as the problem area, refer to Chapter 5 for detailed troubleshooting and service procedures.

2-6 TIMING AND SYNCHRONIZING

Correct timing and synchronization between the fuel and ignition systems is essential to efficient powerhead operation. A powerhead may be in apparently excellent mechanical condition, but perform poorly, unless the timing



The timing and synchronizing adjustments are easily accessible, after the powerhead cowling has been removed.

and synchronization have been adjusted precisely, according to the Specifications in the Appendix and the "Timing and Synchronizing" instructions -- presented in Chapter 6.

Battery Check

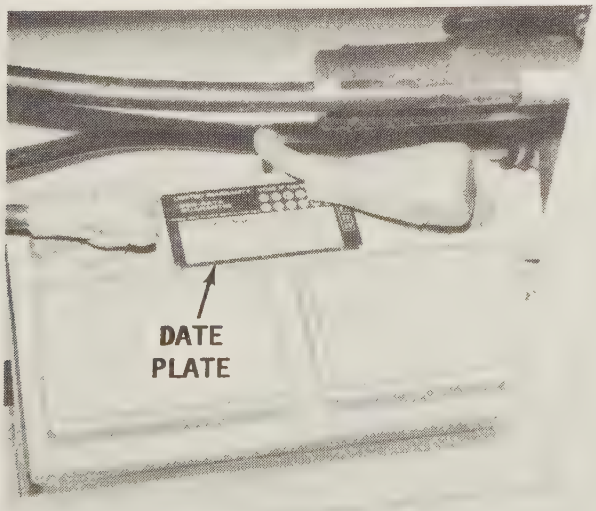
Inspect and service the battery, cables and connections. Check for signs of corrosion. Inspect the battery case for cracks or bulges, dirt, acid, and electrolyte leakage. Check the electrolyte level in each cell.

Fill each cell to the proper level with distilled water or water passed thru a demineralizer.

Clean the top of the battery. The top of a 12-volt battery should be kept especially clean of acid film and dirt, because of the high voltage between the battery terminals. For best results, first wash the battery with a diluted ammonia or baking soda solution to neutralize any acid present. Flush the solution off the battery with clean water. Keep the vent plugs tight to prevent the neutralizing solution or water from entering the cells.

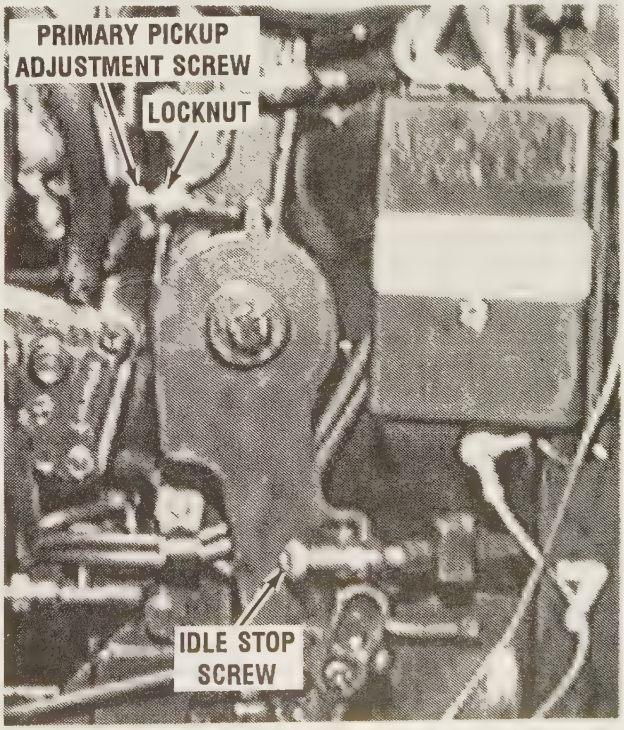
Check to be sure the battery is fastened securely in position. The hold-down device should be tight enough to prevent any movement of the battery in the holder, but not so tight as to place a strain on the battery case.

If the battery posts or cable terminals are corroded, the cables should be cleaned separately with a baking soda solution and a wire brush. Apply a thin coating of Multipurpose Lubricant to the posts and cable

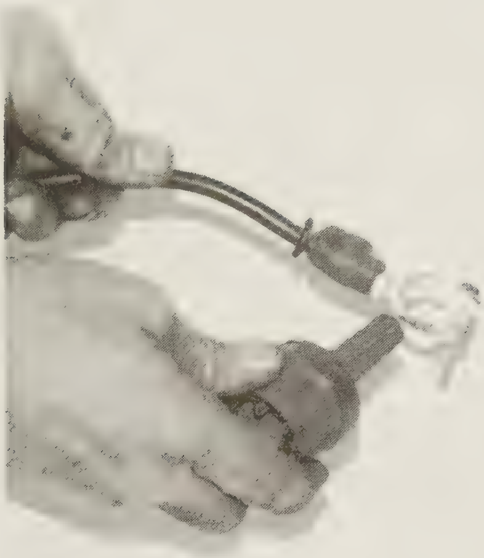


Keep an eye on the date plate affixed to the battery. Batteries seldom have a useful life the full length of their advertised life expectancy.

A check of the electrolyte in the battery should be a regular task on the maintenance schedule on any boat.



After the locknut has been loosened, the idle adjustment screw, also known as the primary pickup adjustment screw, controls the ignition timing at idle. The idle stop screw is close by and controls the speed of the powerhead -- through the throttle shutter opening.



An inexpensive brush should be purchased and used to clean the battery terminals. Clean terminals will ensure a proper connection.

clamps before making the connections. The lubricant will help to prevent corrosion.

If the battery has remained under-charged, check for high resistance in the charging circuit. If the battery appears to be using too much water, the battery may be defective, or it may be too small for the job.

*Common set of jumper cables for using a second battery to crank and start the engine. **EXTREME** care should be exercised when using a second battery, as explained in the text.*

Jumper Cables

If booster batteries are used for starting an engine the jumper cables must be connected correctly and in the proper sequence to prevent damage to either battery, or the rectifier diodes.

ALWAYS connect a cable from the positive terminals of the dead battery to the positive terminal of the good battery **FIRST. NEXT,** connect one end of the other cable to the negative terminals of the good battery and the other end of the **ENGINE** for a good ground. By making the ground connection on the engine, if an arc is created when the connection is made, it will not be near the battery. An arc near the battery could cause an explosion, destroying the battery and causing serious personal injury.

DISCONNECT the battery ground cable before replacing an alternator or before connecting any type of meter to the alternator.

If it is necessary to use a fast-charger on a dead battery, **ALWAYS** disconnect one of the boat cables from the battery first, to prevent burning out the diodes in the rectifier.

NEVER use a fast charger as a booster to start the engine because the diodes in the rectifier will be **DAMAGED.**

Alternator Charging

When the battery is partially discharged, the ammeter should change from discharge to charge between 800 to 1000 rpm for all models. If the battery is fully-charged, the rpm will be a little higher.

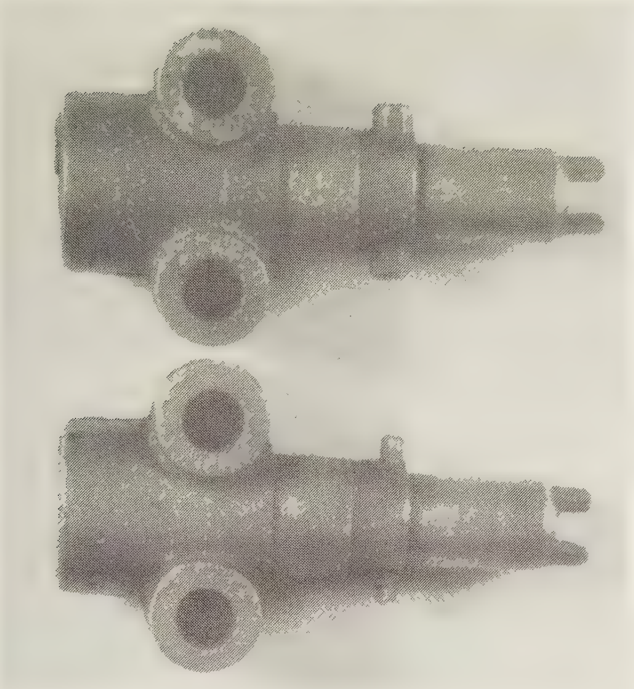
Before disconnecting the ammeter, reconnect the red harness lead to the positive battery terminal and install the wing nut.

Most problems in the charging system can be attributed to: burned diodes -- inside the rectifier or inside the regulator **OR** to burned stator coil connections -- under the flywheel. Both these conditions will lead to an under charged battery. A defective rectifier may cause the battery to "overcharge" or prevent the battery from being "fully charged".

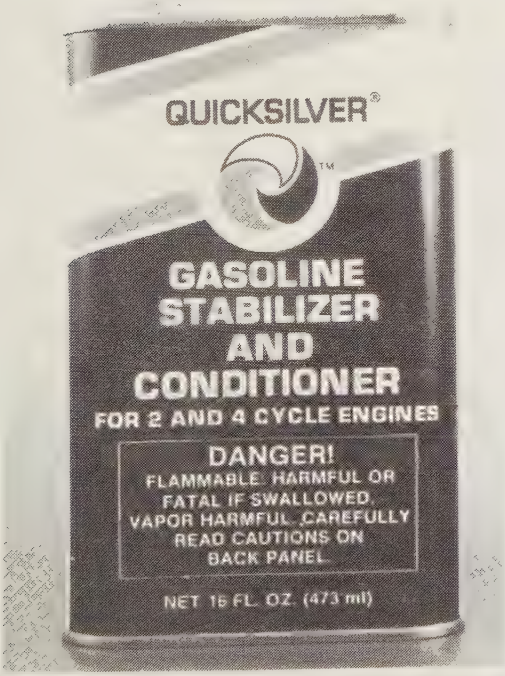
2-7 CARBURETOR ADJUSTMENT

Fuel and Fuel Tanks

Take time to check the fuel tank and all of the fuel lines, fittings, couplings, valves, flexible tank fill and vent. Turn on the fuel



A worn fuel coupling, bottom, compared with a new one, top. Notice how the pins on the worn coupling are smaller and tapered. For the modest cost involved and to ensure a proper connection, the coupling and line should be replaced if there is any sign of excessive wear.



Quicksilver Gasoline Stabilizer and Conditioner m. be used to keep the gasoline in the tank fresh. Such an additive will prevent the fuel from "souring" for up to twelve months.

supply valve at the tank. If the gas was not drained at the end of the previous season, make a careful inspection for gum formation. When gasoline is allowed to stand for long periods of time, particularly in the presence of copper, gummy deposits form. This gum can clog the filters, lines, and passageways in the carburetor.

If the condition of the fuel is in doubt, drain, clean, and fill the tank with fresh fuel.

Fuel pressure at the top carburetor should be checked whenever a lack of fuel volume at the carburetor is suspected.

Check other than Mercury fuel tank for the following:

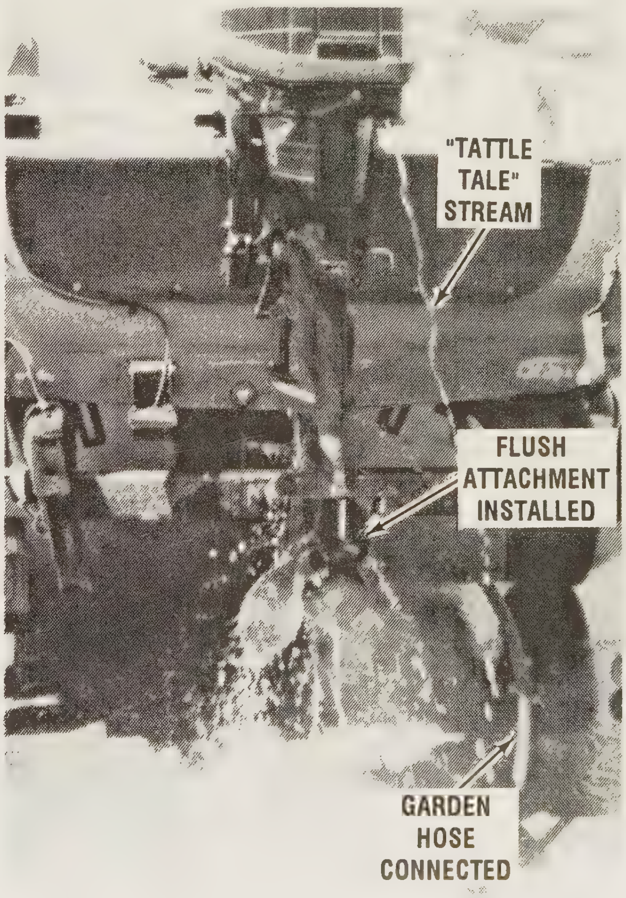
a- Adequate air vent in the fuel cap.

b- In-line fuel filter between pump and carburetor needs attention.

c- Fuel line of sufficient size, should be 5/16" to 3/8".

d- Filter on the end of the pickup is too small or is clogged.

e- Fuel pickup tube is too small.



*Using a flush attachment and garden hose while operating the powerhead at **IDLE** speed. **NEVER** operate the powerhead in or out of gear above **IDLE** speed with such a device connected.*

High-speed Adjustment

The high speed jet on all carburetor models is a fixed orifice installed at the factory. However, larger or smaller jets, designed to offset the effects of higher altitude operation are available from the local marine dealer. Refer to the Appendix for available jet sizes and Chapter 4 for detailed information on high speed jet replacement.

Idle Mixture Adjustment

The idle mixture and idle speed are set at the factory. Due to local conditions, it may be necessary to adjust the carburetor while the powerhead is running and the outboard is mounted in a test tank or with the boat in a body of water. For maximum performance, the idle mixture and the idle rpm should be adjusted under actual operating conditions.

Each WMH carburetor has two idle mixture screws. The mixture screws are set at the factory and have limiter caps installed to prevent no more than 3/4 rotation of the idle mixture screw in either direction. If local conditions require an adjustment be made, then all mixture screws **MUST** be turned the same amount and in the same direction for the powerhead to operate properly. Rotating the screw **CLOCKWISE** will lean the mixture (less fuel), and rotating the screw **COUNTERCLOCKWISE** will richen the fuel mixture (more fuel).

Start the powerhead and allow it to warm to operating temperature.

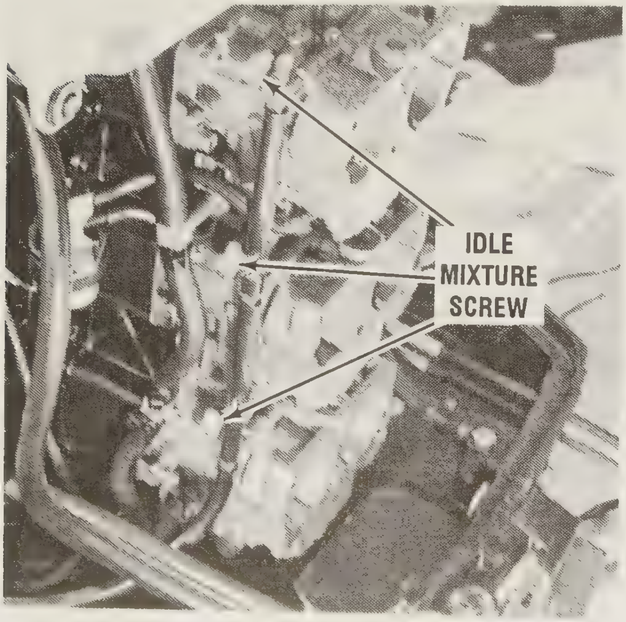
CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

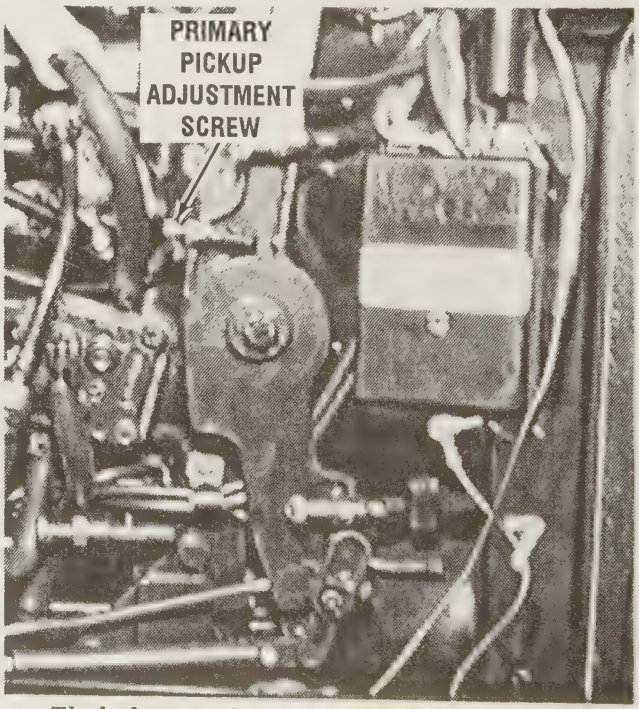
NEVER, AGAIN -- NEVER, operate the powerhead at high speed with a flush device attached. The powerhead, operating at high speed with such a device attached, would **RUNAWAY** from lack of a load on the propeller, causing extensive damage.

With the powerhead operating and the lower unit in **FORWARD** gear, slowly rotate the idle mixture screw **COUNTERCLOCKWISE** until the affected cylinders start to load up or fire unevenly, due to an over-rich mixture. Slowly rotate the idle mixture screw **CLOCKWISE** until the affected cylinders fire evenly and powerhead rpm increases. Continue to slowly rotate the screw **CLOCKWISE** until too lean a mixture is obtained and the rpms fall off and the powerhead begins to misfire.

Now, set the idle mixture screw one-quarter



The adjustment screws called out in the illustration control the air/fuel mixture for the portside carburetor throats (barrels). Identical screws on the other side control the mixture for the starboard side carburetor throats.



The locknut on the primary pickup adjustment screw must be loosened before the setting can be changed, as described in the text.

(1/4) turn out (counterclockwise) from the lean-out position. This adjustment will result in an approximate true setting. A too-lean setting is a major cause of hard starting a cold powerhead.

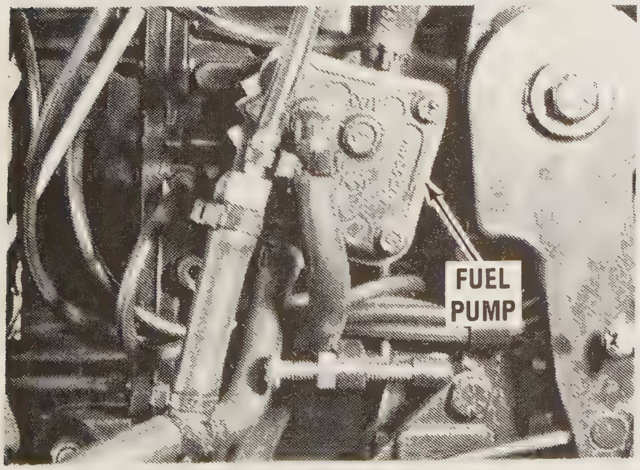
It is better to have the adjustment on the rich side rather than on the lean side. Stating it another way, do not make the adjustment any leaner than necessary to obtain a smooth idle.

If the powerhead hesitates during acceleration after adjusting the idle mixture, the mixture is too lean. Enrich the mixture slightly, by rotating the adjustment screw outward -- **COUNTERCLOCKWISE** until the powerhead accelerates correctly.

Check the idle speed after making any idle fuel mixture adjustments. If the idle speed is above or below the recommended range, loosen the locknut for the "Primary Pick-up" adjustment screw on the powerhead throttle lever. With the powerhead idling, and the lower unit in **FORWARD** gear, adjust the primary pick-up screw until the recommended idle speed of 600-700 rpm is obtained. Tighten the locknut to hold the adjustment.

WO-9 CARBURETORS

Models utilizing six WO-9 carburetors **DO NOT** have idle mixture screws, but rather idle mixture jets. These jets are replaceable fixed orifices installed at the factory for operation of the powerhead at altitudes from sea level to 2500 feet. If local conditions require a change of the idle jets, contact the local marine dealer for specific jet sizes and selection to maximize the performance. Refer to Chapter 4 for detailed instructions to replace the idle and main jets.



The fuel pump is easily accessible on the port side of the powerhead. The pump may be removed, serviced, and installed without special tools.

Powerheads with Electronic Fuel Injection (EFI), system need not take any action because the Electronic Control Unit (ECU), automatically compensates for elevation changes.

Repairs and Adjustments

For detailed procedures to disassemble, clean, assemble, and adjust the carburetor, see the appropriate section in Chapter 4 for the carburetor type on the engine being serviced.

2-8 FUEL PUMP

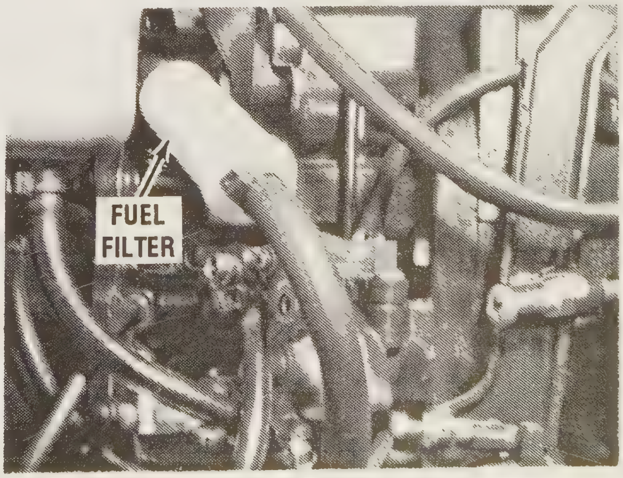
Many times, a defective fuel pump diaphragm is mistakenly diagnosed as a problem in the ignition system. The most common problem is a tiny pin-hole in the diaphragm. Such a small hole will permit gas to enter the crankcase and wet foul the spark plug at idle speed. During high speed operation, gas quantity is limited, and the plug is not fouled and will therefore fire in a satisfactory manner.

If the fuel pump fails to perform properly, an insufficient fuel supply will be delivered to the carburetor. This lack of fuel will cause the powerhead to run lean, lose rpm or cause piston scoring.

When a fuel pressure gauge is added to the system, it should be installed at the end of the fuel line leading to the upper carburetor. To ensure maximum performance, the fuel pressure must be 3 psi or more at full throttle.

CRITICAL ELECTRIC FUEL PUMP WORDS

If an aftermarket electric fuel pump; is to be installed on a powerhead with oil injection, the fuel pressure at the powerhead **MUST** not



The fuel filter is also located on the port side of the powerhead above the fuel pump. The filter cannot be serviced -- it must be replaced, if seriously clogged.

exceed 2 psi. Excessive fuel pressure would result in almost no oil being mixed with the fuel, because the 2 psi delivered by the oil pump could not override the higher than 2 psi fuel pressure.

THEREFORE, to remove any doubt and give "peace of mind" regarding fuel pressure with an electric pump, the authors highly recommend a pressure regulator set at 2 psi be installed between the electric fuel pump and the powerhead.

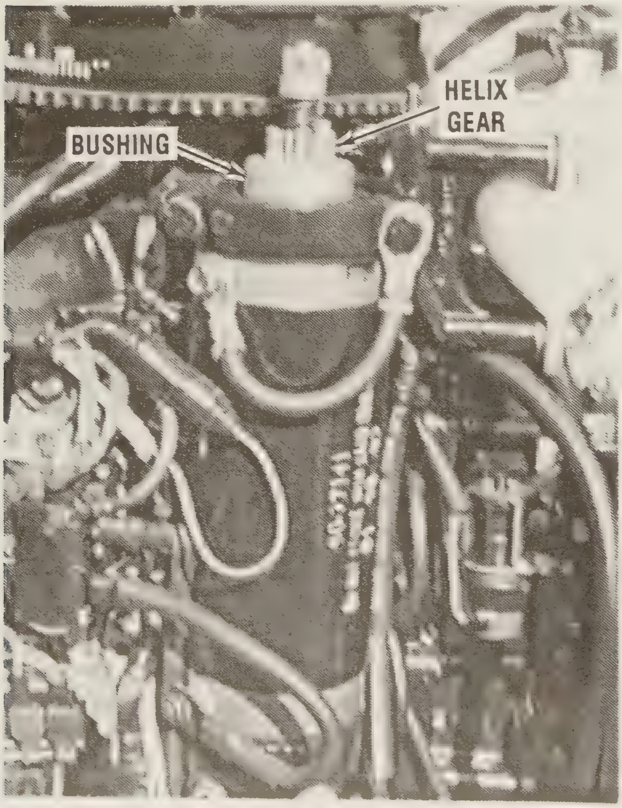
Fuel Filters

Most outboard units covered in this manual have an in-line fuel filter between the fuel pump and the carburetor. These filters are factory sealed units and **CANNOT** be disassembled for cleaning. Instead of cleaning, they **MUST** be replaced with a new filter. If the filter becomes clogged, **BE SURE** to check the fuel tank for contamination.

2-9 CRANKING MOTOR AND SOLENOID

Cranking Motor Test

Check to be sure the battery has a cold cranking amperage rating of 450 amperes and



The cranking motor is fully exposed for lubrication of the helix threads and the bushing below, as mentioned in the text.

is fully charged. Would you believe, many cranking motors are needlessly disassembled in an attempt to solve a cranking problem, when the battery is the actual culprit.

Lift up on the pinion gear and lubricate the helix threads on the armature shaft, and the bushing directly below -- in the end cap -- with a couple drops of SAE 10W oil.

Connect one test lead of a voltmeter to the positive terminal of the cranking motor. Connect the other meter lead to a good ground on the powerhead. Check the battery voltage under load by turning the ignition switch to the **START** position and observing the voltmeter reading.

If the reading is 9-1/2 volts or greater, and the cranking motor fails to operate, repair or replace the unit. See Chapter 7.

Solenoid Test

Obtain an ohmmeter and set the meter to the Rx1 scale. Disconnect all leads from the starter solenoid. Connect each of the ohmmeter leads to the two large solenoid terminals. Connect one 12-volt power cable to one solenoid terminal. Make momentary contact with the other battery cable to the other solenoid terminal. The solenoid should click and the ohmmeter indicate zero ohms resistance.

If the meter indicates greater than zero ohms -- or less than full continuity -- the solenoid is defective and **MUST** be replaced.

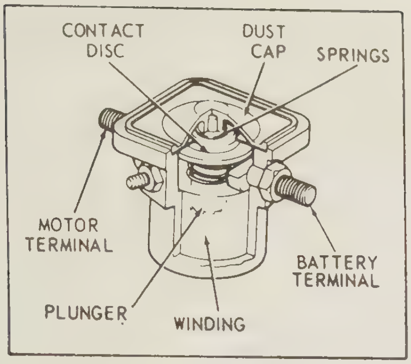
If the solenoid is found to be in satisfactory condition, refer to Chapter 7 for a comprehensive troubleshooting chart covering the cranking motor circuit.

2-10 INTERNAL WIRING HARNESS

Check the internal wiring harness if problems have been encountered with any of the electrical components. Check for frayed or chafed insulation and/or loose connections between wires and terminal connections.

Check the harness connector for signs of corrosion. Inspect the electrical "prongs" to be sure they are not bent or broken. If the harness shows any evidence of the foregoing problems, the trouble must be corrected before proceeding with any harness testing.

Verify the "prongs" of the harness connector are clean and free of corrosion. Leave no doubt about the connection being made between the



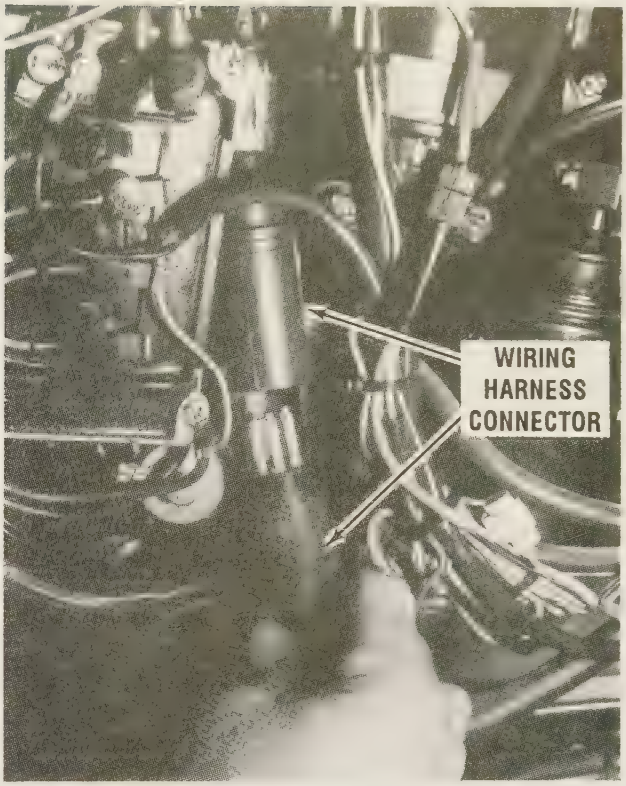
Exploded view of a cranking motor solenoid.

harness connector and the remote control harness. It **MUST** be in excellent condition.

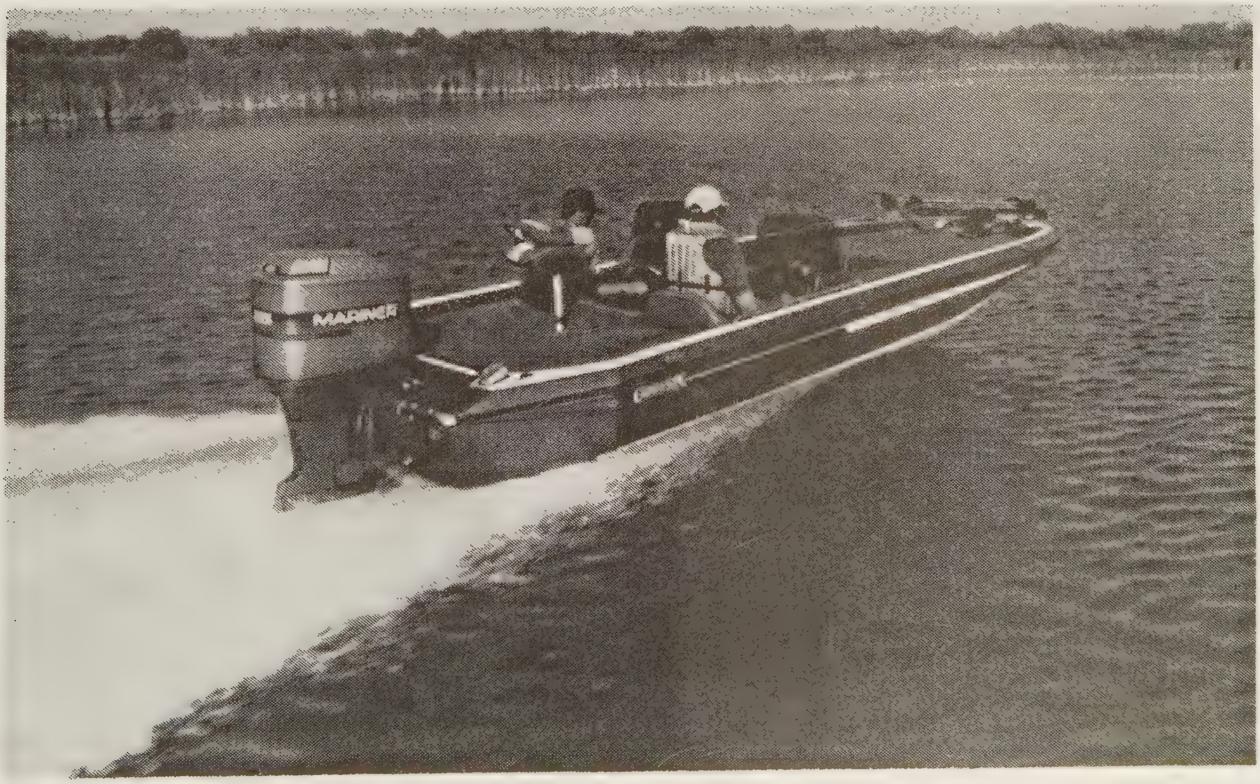
Short Test

Refer to the appropriate wiring diagram in the Appendix.

Disconnect the internal wiring harness from the electrical components. Use an ohmmeter set on the Rx1 scale and check for continuity between any of the wires in the harness. Use the Rx1 scale and check for continuity between any wire and a good ground. If continuity exists, the harness **MUST** be repaired or replaced.



Typical wiring harness connector. The "prongs" should be clean, straight and of course -- unbroken. Use ***CARE*** *when connecting or disconnecting to prevent damaging the "prongs".*

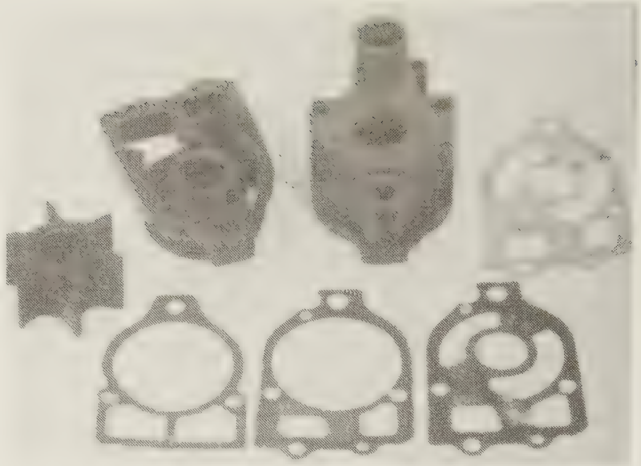


A properly tuned powerhead certainly adds to the day's enjoyment on the water.

Resistance Test

Refer to the Wiring Diagram in the Appendix.

Obtain an ohmmeter and set the meter to the Rx100 scale. Use the Wiring Diagram in the Appendix and check each wire for resistance between the harness connection and the terminal end. If the resistance is 100 ohms or less, the harness is in satisfactory condition. If the reading is over 100 ohms, the wire or terminal end is damaged and the harness **MUST** be repaired or replaced.

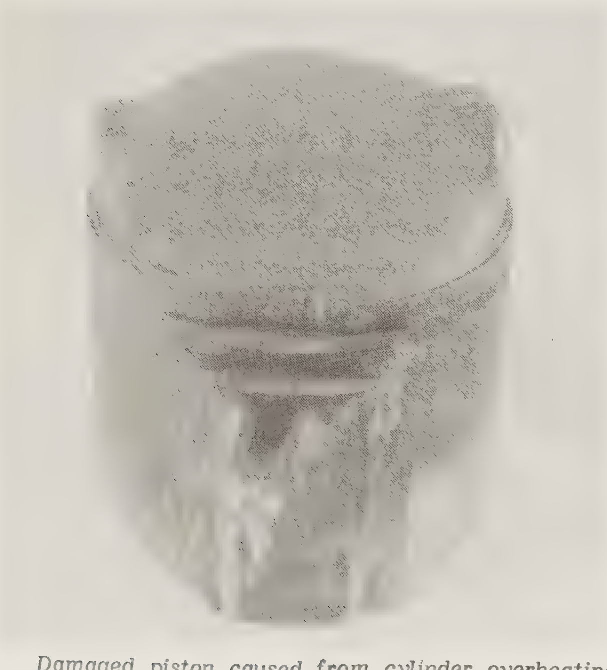


Major parts included in a water pump kit, available at the local marine dealer at modest cost.

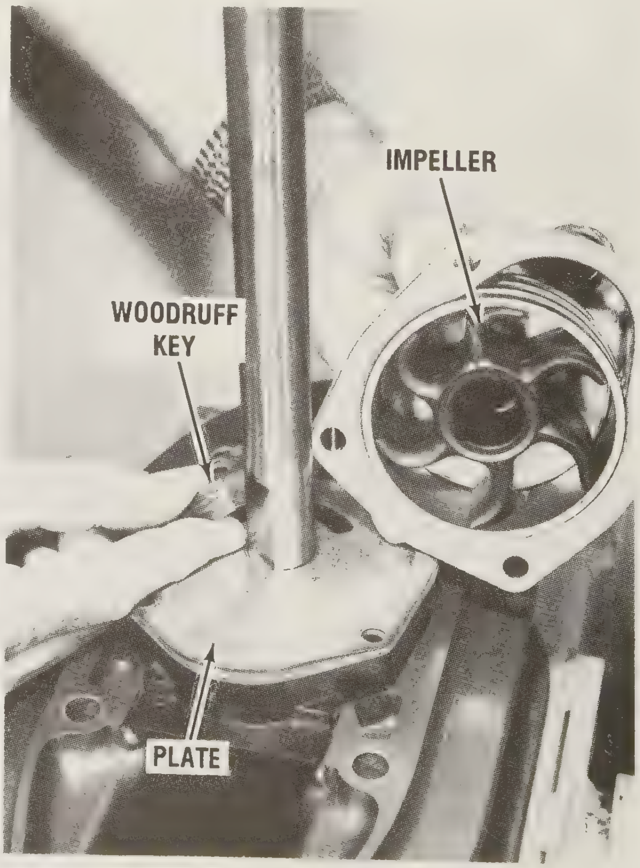
2-11 WATER PUMP CHECK

FIRST A GOOD WORD: The water pump **MUST** be in very good condition for the engine to deliver satisfactory service. The pump performs an extremely important function by supplying enough water to properly cool the engine. Therefore, in most cases, it is advisable to replace the complete water pump assembly at least once a year, or anytime the lower unit is disassembled for service.

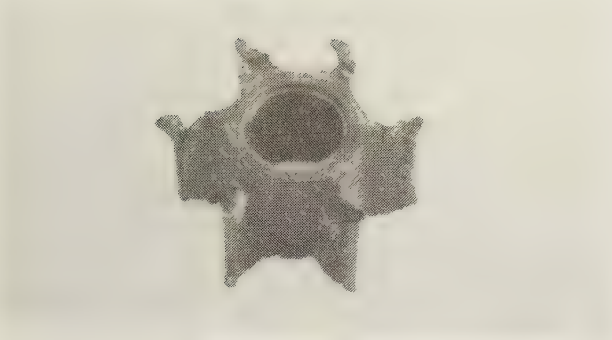
Sometimes during adjustment procedures, it is necessary to run the engine with a flush device attached to the lower unit. **NEVER** operate the engine over 1000 rpm with a flush device attached, because the engine may **"RUNAWAY"** due to the no-load condition on the propeller. A "runaway" engine could be severely damaged. As the name implies, the flush device is primarily used to flush the engine after use in salt water or contaminated fresh water. Regular use of the flush device will prevent salt or silt deposits from accumulating in the water passage-way. During and immediately after flushing, keep the motor in an upright position until all of the water has



Damaged piston caused from cylinder overheating when the cooling system failed to provide adequate coolant.



Close view showing internal parts of the water pump installed on the powerheads covered in this manual.

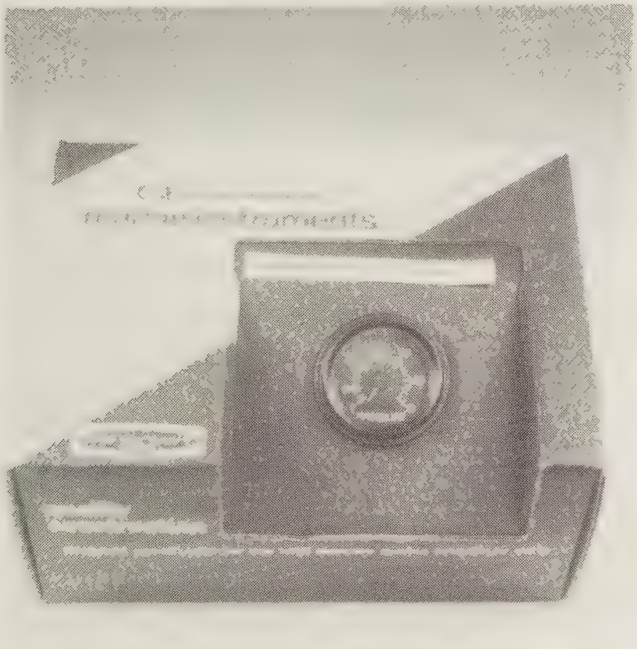


Worn water pump impeller, unfit for service.

drained from the drive shaft housing. This will prevent water from entering the power head by way of the drive shaft housing and the exhaust ports, during the flush. It will also prevent residual water from being trapped in the drive shaft housing and other passageways.

Most outboard engines have water exhaust ports which deliver a tattle-tale stream of water, if the water pump is functioning properly during engine operation. Water pressure at the cylinder block should be checked if an overheating condition is detected or suspected.

To test the water pump, the lower unit **MUST** be placed in a test tank or the boat moved into a body of water. The pump must now work to supply a volume to the engine. A tattle-tale stream of water should be visible from the ports.



A water pressure gauge kit available from the local marine dealer. All necessary parts and fittings to complete the installation, are included in the package.

A water pressure gauge kit is available from the local marine dealer for use with most outboard units. This kit, when installed, will indicate the amount of water pressure the pump is delivering to the powerhead at all times. The first time the pressure indication falls off, the pump should be serviced. To install the gauge kit, follow the instructions contained in the kit. Place the water pressure gauge in a convenient position for viewing by the helmsperson. Water pressure at full throttle should be 12 psi or greater. During violent operating conditions, such as sharp turns, or other quick maneuvers, the pressure **MUST** not fall below 5 psi.

Lack of adequate water supply from the water pump thru the engine will cause any number of power head failures, such as stuck rings, scored cylinder walls, burned pistons, etc.

2-12 PROPELLER

Inspect the propeller blades for nicks, cracks, or bent condition. If the propeller is damaged, the local marine dealer can make repairs or send it out to a shop specializing in such work.

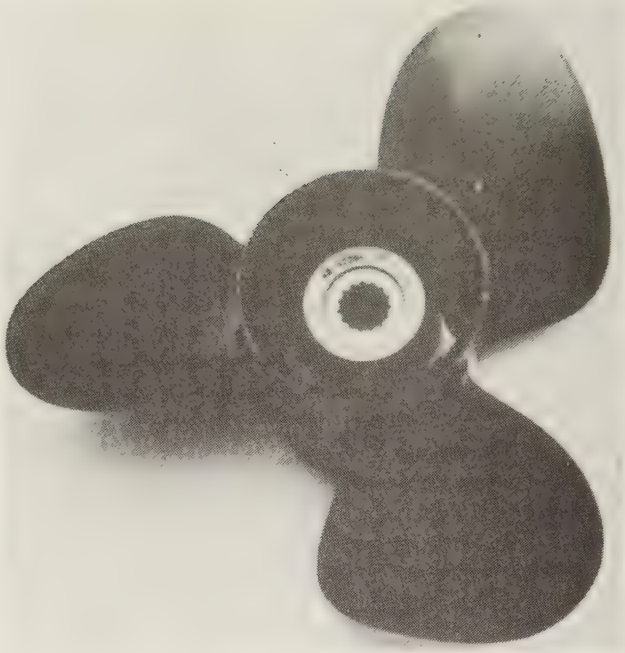
Check with the local marine dealer, or a propeller shop for the recommended size and pitch for a particular size engine, boat, and intended operation. The correct propel-

Example of a damaged propeller. This unit should have been replaced long before this much damage was sustained.

Damage was caused to this unit when the propeller struck an underwater object. If the propeller should suffer this much abuse, the propeller shaft should be carefully checked.

ler should be installed on the engine to enable operation at the upper end of the factory recommended rpm.

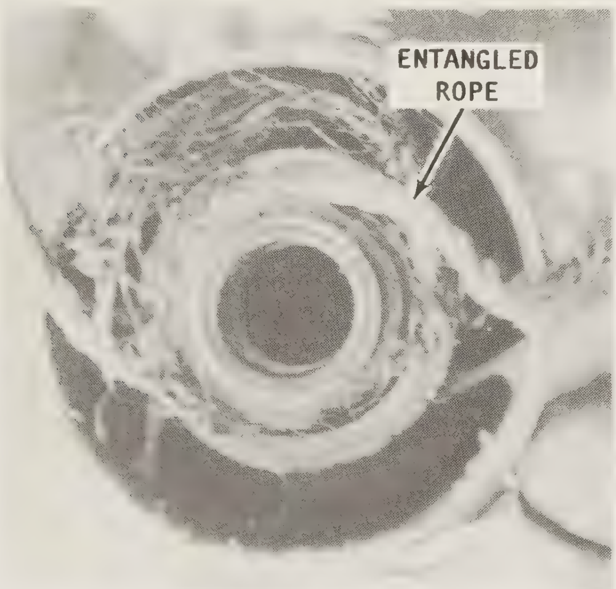
If the powerhead rpm is below the rated rpm range, use a smaller or less pitch propeller. The reason for adjusting to the "high" side of the rpm range is to compensate if a heavier load is carried in the boat, the wide open throttle (WOT) rpm will not drop substantially. If the powerhead rpm is above the recommended rpm, try a higher pitch propeller or the same pitch cupped. See Chapter 1 for explanation of propeller terms, pitch, diameter, cupped, etc. One size smaller propeller usually gives best performance for water skiing.



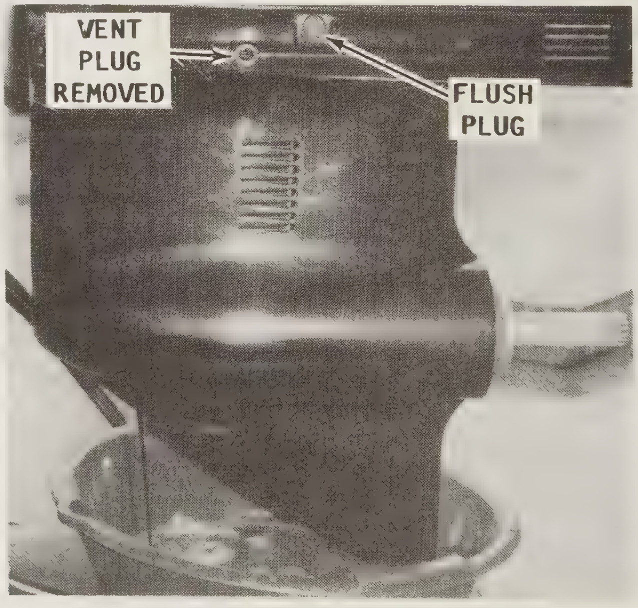
New propeller ready for installation and service.

For a dual engine installation, the next higher pitch propeller may prove the most satisfactory arrangement for water skiing.

Remove the propeller and the thrust hub. Check the propeller shaft seal to be sure it is not leaking. Check the area just forward of the seal to be sure a fish line is not wrapped around the shaft.



This rope became entangled behind the propeller around the propeller shaft. The propeller should be removed periodically and this area checked for foreign material.



The amount of lubricant in the lower unit should be checked on a daily basis during the operating season. The lubricant should be drained and replenished every 100 hours of operation.

2-13 LOWER UNIT

NEVER remove the vent or filler plugs when the lower unit is hot. Expanded lubricant would be released through the plug hole. Check the lubricant level after the unit has been allowed to cool. Add only Super-Duty Gear Lubricant. **NEVER** use regular automotive-type grease in the lower unit, because it expands and foams too much. Outboard lower units do not have provisions to accommodate such expansion.

If the lubricant appears milky brown, or if large amounts of lubricant must be added to bring the lubricant up to the full mark, a thorough check should be made to determine the cause of the loss.

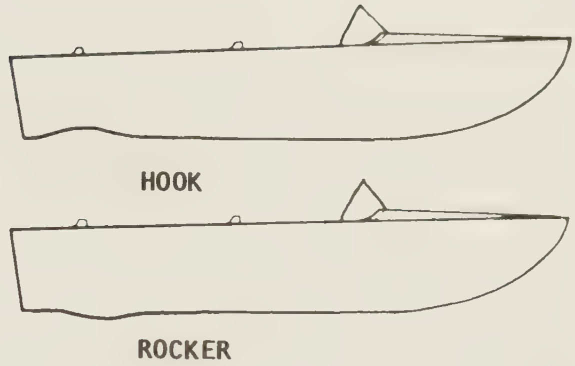
Draining Lower Unit

Remove the **FILL** plug from the lower end of the gear housing on the port side and the **VENT** plug just above the anti-cavitation plate.

Filling Lower Unit

Position the drive unit approximately vertical and without a list to either port or starboard. Insert the lubricant tube into the **FILL/DRAIN** hole at the bottom plug hole,

*Filling the lower unit with new lubricant. Notice the unit is filled through the lower plug, but the upper plug **MUST** be removed to allow trapped air to escape.*



Boat performance will be drastically impaired, if the bottom is damaged by a dent (hook) or bulge (rocker).

and inject lubricant until the excess begins to come out the **VENT** hole. Install the **VENT** plug first then replace the **FILL** plug with **NEW** gaskets. Check to be sure the gaskets are properly positioned to prevent water from entering the housing.

For detailed lower unit service procedures, see Chapter 9. For lower unit lubrication capacities, see the Appendix.

The manufacturer recommends the use of his brand name lubricant to service the lower unit.

2-14 BOAT TESTING

Operation of the outboard unit, mounted on a boat with some type of load, is the ultimate test. Failure of the power unit or the boat under actual movement through the water may be detected much more quickly than operating the power unit in a test tank.

Hook and Rocker

Before testing the boat, check the boat bottom carefully for marine growth or evidence of a "hook" or a "rocker" in the bottom. Either one of these conditions will greatly reduce performance.

Performance

Mount the motor on the boat. Install the remote control cables and check for proper adjustment.

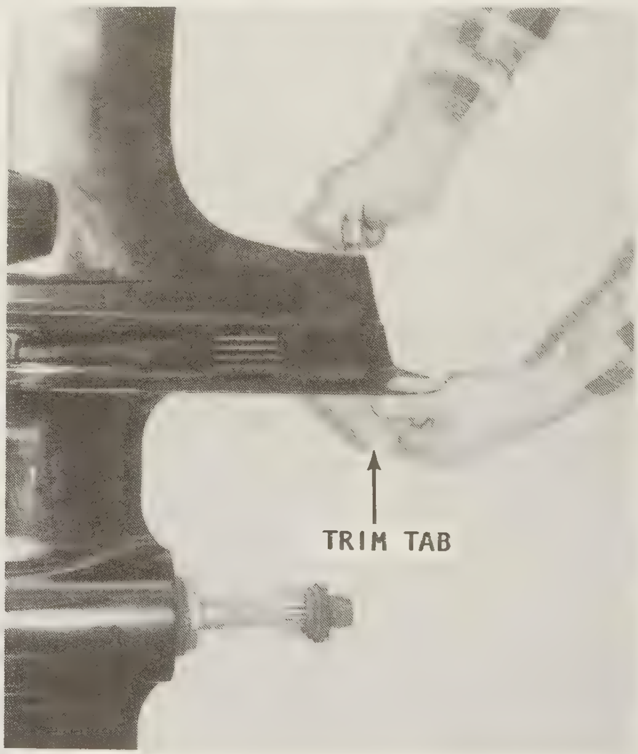
Make an effort to test the boat with what might be considered an average gross load. The boat should ride on an even keel, without a list to port or starboard. Adjust the motor tilt angle, if necessary, to permit the bow to ride slightly higher than the stern. If heavy supplies are stowed aft of the center, the bow will be light and the boat will "plane" more efficiently. For this test the boat must be operated in a body of water.

If the motor is equipped with an adjustable trim tab, the tab should be adjusted to permit boat steerage in either direction with equal ease.

Check the engine rpm at full throttle. The rpm should be within the Specifications in the Appendix. If the rpm is not within specified range, a propeller change may be in order. A higher pitch propeller will decrease rpm, and a lower pitch propeller will increase rpm.

For maximum low speed engine performance, the idle mixture and the idle rpm should be readjusted under actual operating conditions.

Maximum engine performance can only be obtained through proper tuning using a tachometer.



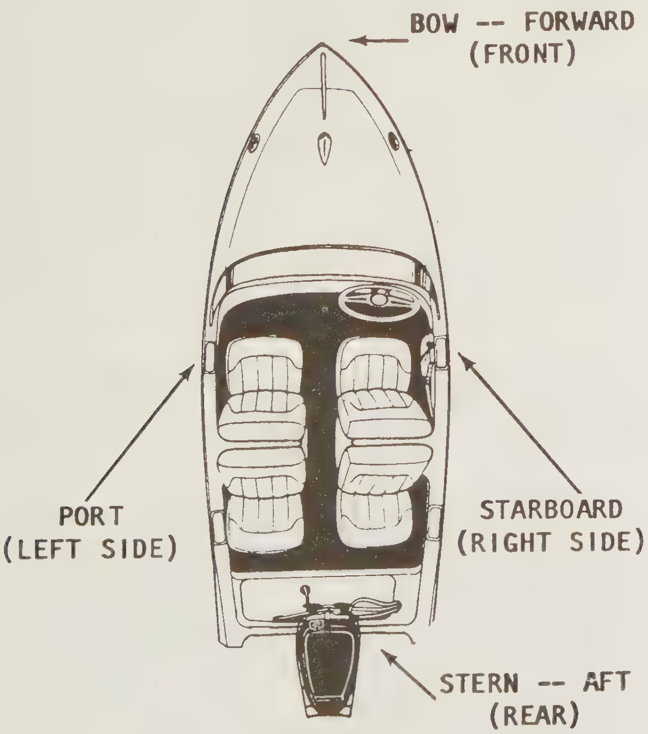
Adjusting the trim tab to receive optimum performance from the boat and power unit.

3
MAINTENANCE

3-1 INTRODUCTION

GOOD WORDS: The authors estimate 75% of engine repair work can be directly or indirectly attributed to lack of proper care for the engine. This is especially true of care during the off-season period. There is no way on this green earth for a mechanical engine, particularly an outboard motor, to be left sitting idle for an extended period of time, say for six months, and then be ready for instant satisfactory service.

Imagine, if you will, leaving your automobile for six months, and then expecting to turn the key, have it roar to life, and be able to drive off in the same manner as a daily occurrence.



Common terminology used throughout the world for reference designation on boats of all sizes. These are the terms used in this book.

It is critical for an outboard unit to be operated at least once a month, preferably, in the water. If this is not possible, then a flush attachment **MUST** be connected to the lower unit and water supplied from a garden hose.

CAUTION
Water must circulate through the lower unit to the powerhead any time the powerhead is operated to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

NEVER, again **NEVER** operate the powerhead above an idle speed with a flush device attached. The powerhead operating at high speed under such conditions could actually **RUNAWAY** from lack of a load on the propeller, causing extensive and expensive damage.

3-2 OUTBOARD SERIAL NUMBERS

The outboard serial numbers are the manufacturer's key to changes. These numbers identify the year of manufacture, the qualified horsepower rating of the unit, and the parts book identification. If any correspondence or parts are required, the outboard serial number **MUST** be used or proper identification is not possible. The accompanying illustration will be very helpful in locating the outboard identification tag.

ONE MORE WORD
The serial number establishes the year in which the outboard unit was produced and not necessarily the year of first installation.

Two serial number locations are used on each of the outboard units covered in this manual. The most accessible location is on the

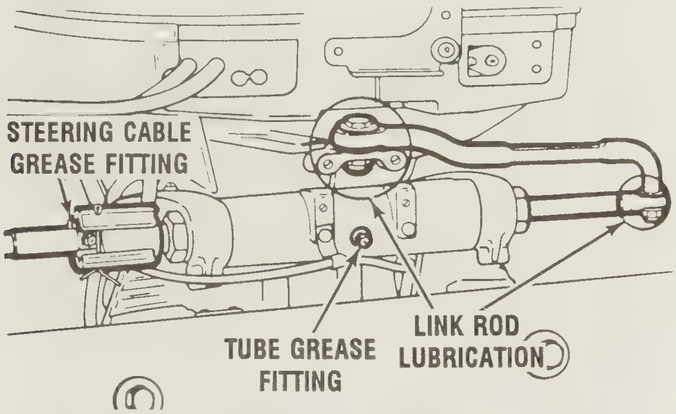
serial/instruction plate affixed to the swivel bracket. The other location is on the powerhead cylinder block.

3-3 LUBRICATION -- COMPLETE UNIT

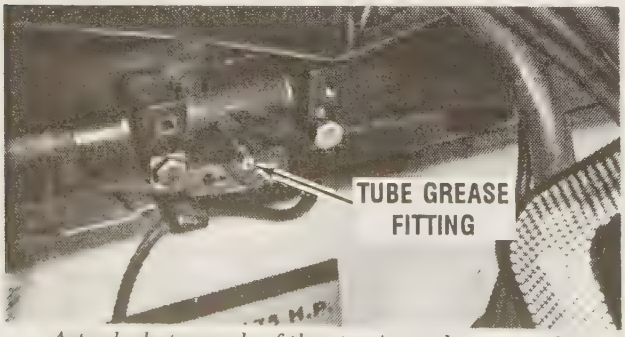
As with every type mechanical invention with moving parts, lubrication plays a prominent role in operation, enjoyment, and longevity of the unit.

If an outboard unit is operated in salt water the frequency of applying lubricant to fittings is usually cut in half for the same fitting if the unit is used in fresh water. The few minutes involved in moving around the outboard applying lubricant and at the same time making a visual inspection of its general condition will pay in rich rewards with years of continued service.

It is not uncommon to see outboard units well over 20-years of age moving a boat through the water as if the unit had recently been purchased from the current line of models. An inquiry with the proud owner will undoubtedly reveal his main credit for its performance to be regular periodic maintenance.



Line drawing to depict the steering cable grease fittings and pivot point lubrication points, not shown in the illustration below.



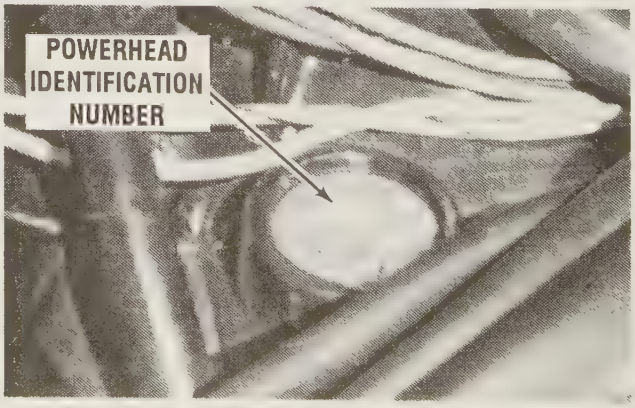
*Actual photograph of the steering tube grease fitting. The steering cable core **MUST** be completely retracted into the housing **BEFORE** applying lubricant at the fitting. Failure to retract, could cause hydraulic lock of the cable.*

Typical location of the serial/installation plate affixed to the transom bracket of the powerheads covered in this manual.

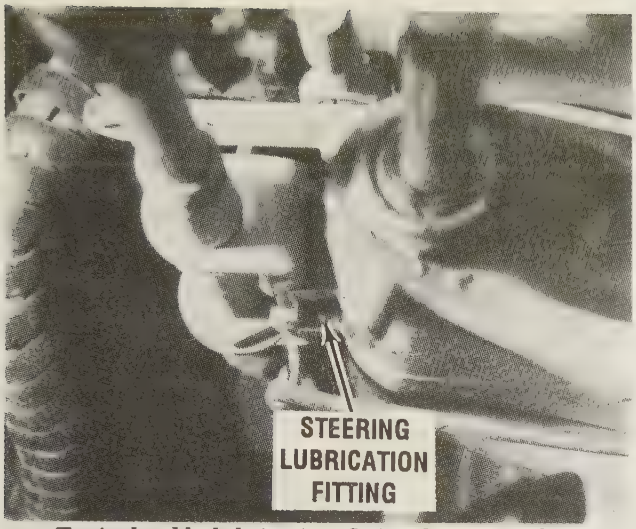
The following chart can be used as a guide to periodic maintenance while the outboard unit is being used during the season.

In addition to the normal lubrication listed in the lubrication chart, the prudent owner will inspect and make checks on a regular basis as outlined in the chart on Page 3-5.

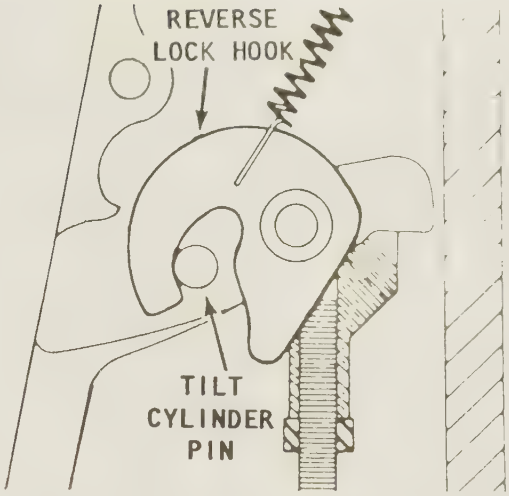
General storage instructions are presented later in the chapter under "Winter Storage". Following the "Storage" instructions will **ENSURE** easier start-up preparation at the beginning of the next season, as explained in the next section. Considerable maintenance costs can be saved by taking a little extra time at the end of the season, as explained throughout this chapter.



The powerhead identification number is stamped on the plug in the block casting "riser" opening, located on top of the block -- the forward section.



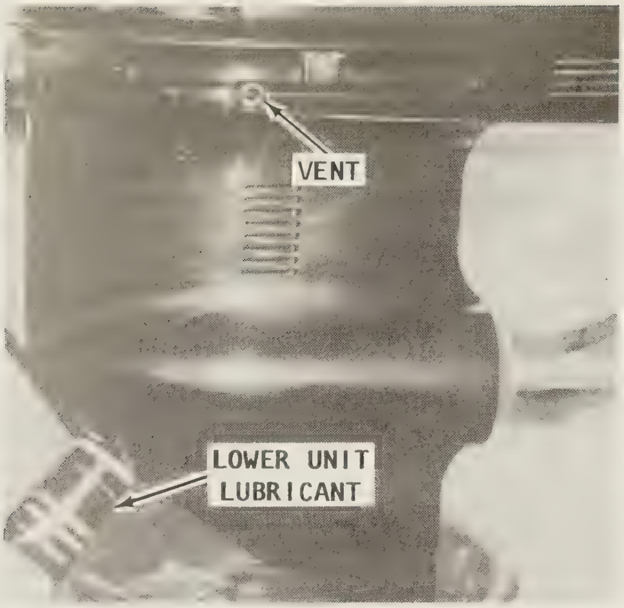
Typical cable lubrication fitting location. Servicing this point every 60 days will contribute to smooth steering.



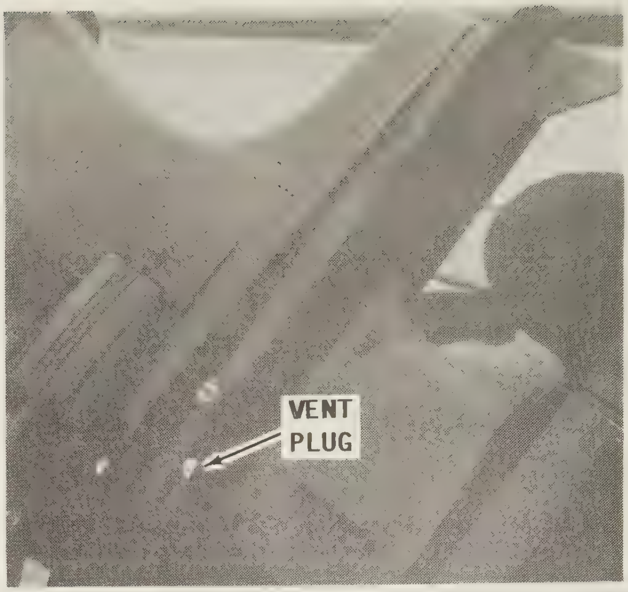
The under surface of the reverse lock hook should be lubricated where it contacts the tilt cylinder pin.

LUBRICATION POINT/FREQUENCY CHART

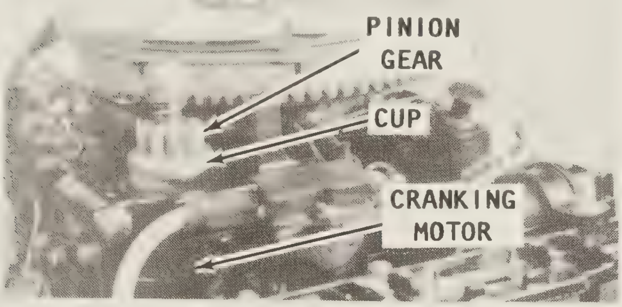
<table>
<tr><th>DESCRIPTION</th><th>LUBRICANT</th><th>FREQUENCY FRESH WATER</th><th>FREQUENCY SALT WATER</th></tr>
<tr><td>Ride-Guide steering cable</td><td rowspan="6">Multipurpose Lubricant</td><td rowspan="8">Every 60 days</td><td rowspan="8">Every 30 days</td></tr>
<tr><td>Throttle linkage and throttle cable</td></tr>
<tr><td>Upper shift shaft</td></tr>
<tr><td>Lube fitting in power trim cylinder</td></tr>
<tr><td>Reverse lock lever</td></tr>
<tr><td>Shift linkage and shift cable</td></tr>
<tr><td>Steering link rod pivot points</td><td>SAE 30W engine oil</td></tr>
<tr><td>Clamp screws</td><td>Anti-Corrosion Lubricant</td></tr>
<tr><td>Propeller shaft</td><td>Perfect Seal</td><td>Once in season</td><td>Every 60 days</td></tr>
<tr><td>Gear housing</td><td>Super-Duty Lubricant</td><td>After 10 days then ea. 30 days</td><td>After 10 days then ea. 30 days</td></tr>
<tr><td>Tilt lock lever</td><td>Multipurpose Lubricant</td><td>Every 60 days</td><td>Every 30 days</td></tr>
<tr><td>Cranking motor pinion gear</td><td>SAE 10W engine oil</td><td>Once ea. season</td><td>Once ea. season</td></tr>
</table>



Filling the lower unit with approved lower unit lubricant. Be sure the vent screw has been removed.

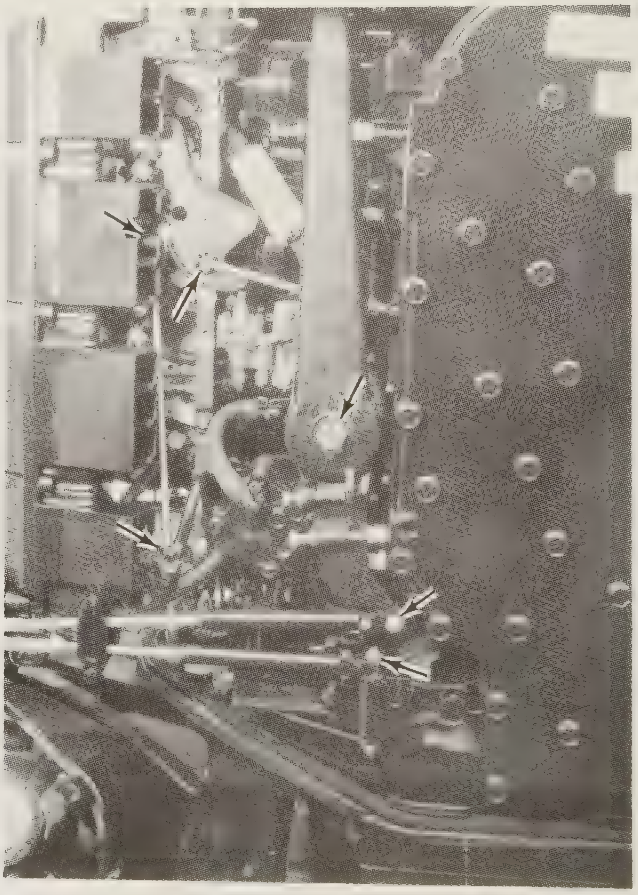


The upper vent plug should be removed periodically and the opening cleaned with a piece of wire. The oil level should be close to the vent hole. Any indication of a "milky" color to the oil means water in the lubricant.



The outer surface of the cup below the pinion gear and the gear should be lubricated periodically.

A coating of waterproof grease will protect the electrical harness connector from corrosion.



Arrows indicate some of the lubrication points for the throttle linkage on a V6 powerhead. Look for "joints" where there is movement between two pieces.

INSPECTION AND CHECKS

Item or Area to be Checked	Every 30 Days	Every 60 Days	Once in Season	Twice in Season
Lubricant level in lower unit	X			
Lubricant level in Power Trim/Tilt	X			
Clean battery terminals				X
Spark plugs & leads			X	
Clean fuel filter/s			X	
Fuel filter on oil injection unit		X		
Fuel filter at fuel tank			X	
All fuel lines and connections				X
Complete outboard -- damaged parts			X	
Cranking motor pinion gear -- lubrication			X	
Propeller for damage		X		
Clean outboard -- touch-up paint			X	

SPECIAL WORDS

Time for inspection, checks, and maintenance can almost be cut in half, if the unit is operated in salt water.

Draining oil from the lower unit. Sample the oil between your fingers for evidence of metal particles.

Adding approved oil to the oil tank. In this case, the tank is located under an aft seat next to the transom. A small reservoir with a low oil warning device is attached to the powerhead.

Remove, inspect, and clean each spark plug at the beginning of each season.

3-4 PRE-SEASON PREPARATION

Satisfactory performance and maximum enjoyment can be realized if a little time is spent in preparing the outboard unit for "action" at the beginning of the season. Assuming the unit has been properly stored, as outlined in Section 3-12, towards the end of this chapter -- a minimum amount of work is required to prepare the unit for use.

The following steps outline an adequate and logical sequence of tasks to be performed before using the outboard the first time in a new season.

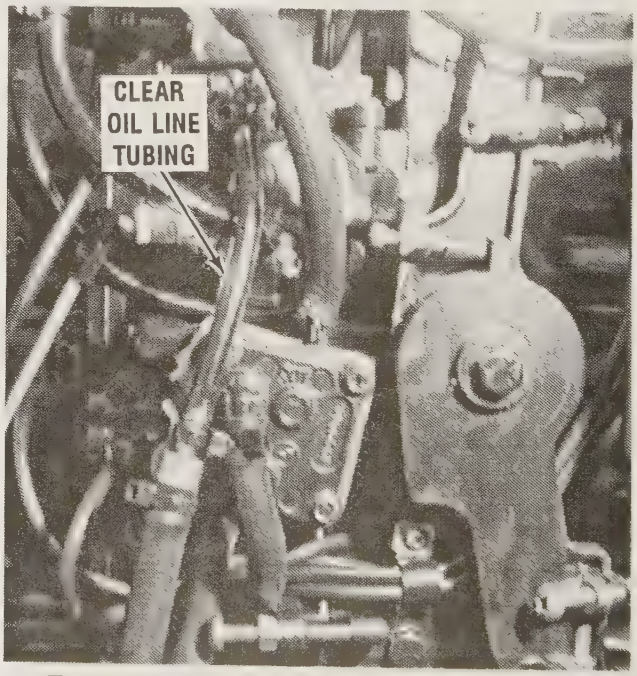
1- Lubricate the outboard according to the manufacturer's recommendations. Refer to the lubrication chart on Page 3-3. Remove, clean, inspect, adjust -- if necessary -- and then install the spark plug with new gaskets -- if gaskets are used. Make a thorough check of the ignition system. This check should include: the trigger coil, switch box, stator assembly, condition of the wiring, and the battery electrolyte level and status of the battery charge.

2- Take time to check the fuel tank and all fuel lines, fittings, couplings, valve, and the flexible tank fill and vent. If the fuel was not drained at the end of the previous season, and a fuel preservative was not added to the fuel, turn on the fuel supply valve at the tank and make a careful inspection for gum formation.

If gasoline is allowed to stand for long periods of time, particularly in the presence of copper -- gummy deposits will form. Such gum can clog filters, lines, and passageways in the carburetor. Check for the odor of rotten eggs. If discovered -- discard all fuel and fill the tank with fresh fuel. It is recommended to mix a 50:1 oil mixture in with the fuel for the first two hours of operation, following a long storage period. This premix oil along with the oil injection system will **ENSURE** adequate lubrication to the powerhead. See Chapter 4, for fuel system service.

3- Check the lubricant level in the lower unit by first removing the vent screw on the port side just above the anti-cavitation plate.

Check the condition of the fuel coupling at the beginning of each new season before attempting to start the powerhead. Make a visual inspection of the fuel lines and connections for any sign of leakage.



Transparent oil line tubing is used between the oil pump and the point it connects with the fuel line prior to entering the fuel pump. Such clear tubing permits the operator to check oil flow.

Insert a short piece of wire into the opening and check the level. Fill the lower unit according to the procedures outlined in Section 3-11.

Oil Injection

4- Check the quantity of oil in the main oil tank -- installed in the boat. The tank is made of translucent white plastic material. Therefore, the quantity of oil in the tank can be quickly and easily determined. The reservoir tank mounted on the powerhead is made of the same material.

Remove the cap and fill the tank with a high quality marine 2-cycle outboard oil. The oil **MUST** have a B.I.A. rating of TC-W or TC-W-II printed on the container. Using any oil not meeting these specifications may result in serious powerhead damage due to a lack of proper lubricating additives in the oil. After the tank is filled, install and tighten the cap.

Take time to examine all the hoses and connections from the oil tank to the oil pump. Check the hoses and connections to either the 2-psi check valve or to the fuel pump, depending on which oil injection system the powerhead is equipped. Check the hoses for damage, cracks and leakage, if any of these conditions are present, the hose **MUST** be replaced.

Check the function of the low oil quantity warning system. If the powerhead is equipped with a test button on the powerhead, set the key switch to the **RUN** position, and then depress the test button. The warning horn should emit a continuous tone. Some models have a warning module system and each time the key switch is placed to the **RUN** position, the warning module will automatically perform a "Self Test" for a few seconds. The horn will emit a "BEEP - BEEP - BEEP" sound to confirm the low oil quantity system is working properly, and then a continuous "BEEP" for the "Overheat Temperature" warning. If the horn fails to sound, check the system according to the detailed instructions in Chapter 7.

A check of the low oil warning device in the oil reservoir should be made to verify the unit slides easily on the shaft.

GOOD WORDS

The manufacturer recommends the fuel filter be replaced at the start of each season or at least once a year. The manufacturer also recommends oil be added to the fuel at the ratio of 50:1 for the first 6-gallons of fuel used after the unit is brought out of a long period of storage. The added oil in the fuel tank **PLUS** the 50:1 oil mixture provided by the oil injection system, will deliver a mixture of 25:1 to the powerhead. This new ratio will **ENSURE** adequate lubrication of moving parts which have been drained of oil during the storage period.

All Units

5- Check and replace any defective hoses. Check to be sure the connections do not leak. If the clamp has lost its tension or if it has

Typical in-line fuel filter installed between the fuel pump and the carburetor. This filter should be replaced once each season or annually.

distorted the hose, replace spring-type hose clamps with band-type clamps.

6- The powerhead can be operated with a flush attachment connected to the lower unit or with the unit in a body of water. If the flush attachment is used, connect a garden hose to the attachment and turn the water on for a few minutes **BEFORE** starting the powerhead.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is operated to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

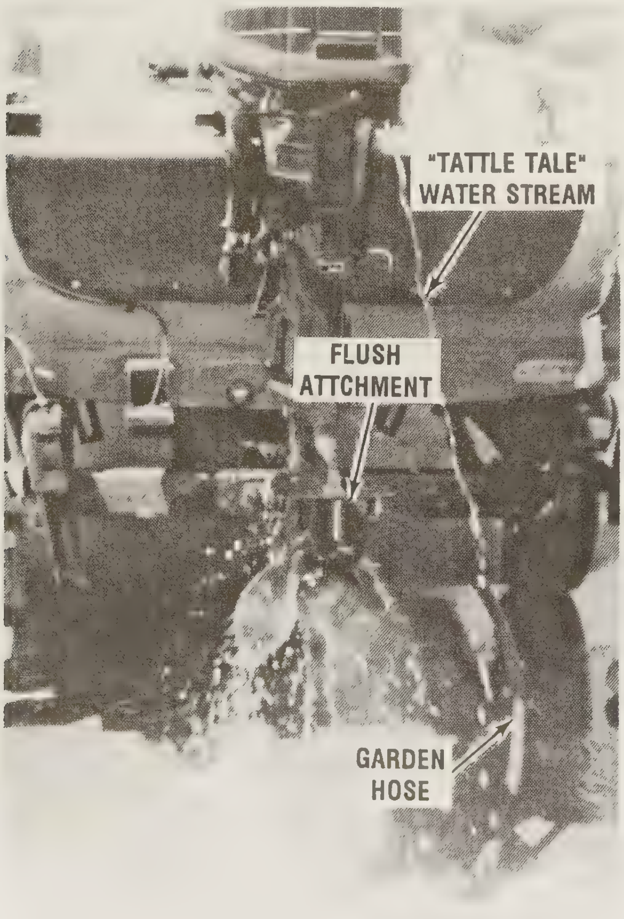
Check for a "tattle tale" stream of water exiting from the exhaust outlet on the starboard side of the outboard unit. This stream verifies the water pump is functioning properly and water is circulating through the powerhead.

7- Check the electrolyte level in the battery and the voltage for a full battery charge. Clean and inspect the battery terminals and cable connections. **TAKE TIME** to check the polarity, if a new battery is being installed. Cover the cable connections with grease or special protective compound as a prevention to corrosion formation. Check all electrical wiring and grounding circuits.

8- Check all electrical parts on the outboard unit and lower portions of the hull to be sure they are not of a type which could cause ignition of an explosive atmosphere. Rubber caps help keep spark insulators clean and reduce the possibility of arcing. The cranking motor, alternator, electric fuel pump -- aftermarket item -- voltage regulator and high-tension wiring harnesses should be of a marine type unable to cause an explosive mixture to ignite.

ONE FINAL WORD

Before putting the boat in the water, **TAKE TIME** to **VERIFY** the drain plugs are installed. Countless number of boating excursions have had a very sad beginning because the boat was eased into the water only to have the boat begin to fill with the "wet stuff" from the river, lake, reservoir -- where ever.



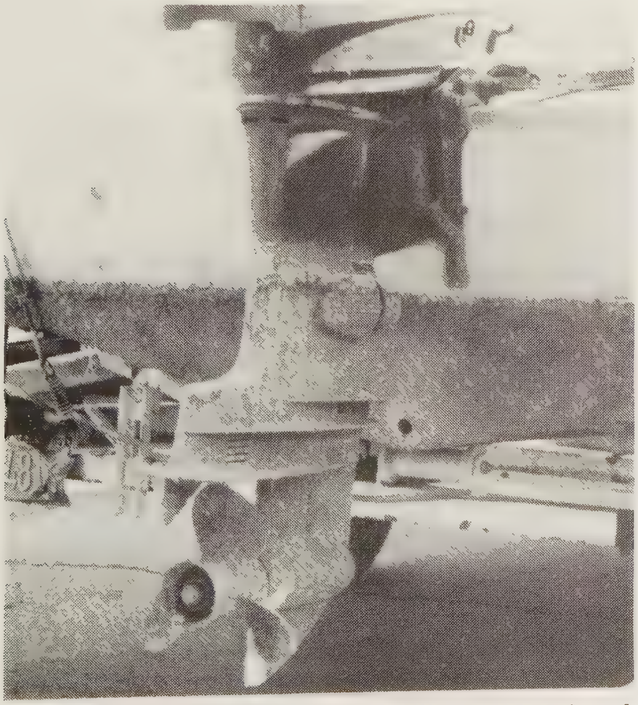
*Garden hose connected to the lower unit flush attachment while the powerhead is operated **ONLY** at idle speed with the outboard unit in **NEUTRAL**.*

An inexpensive two-part tool will do an excellent job of cleaning the battery terminals and the inside of the cable connectors.

3-5 FIBERGLASS HULLS

Fiberglass-reinforced plastic hulls are tough, durable, and highly resistant to impact. However, like any other material they can be damaged. One of the advantages of this type construction is the relative ease with which it may be repaired. Because of its break characteristics, and the simple techniques used in restoration, these hulls have gained popularity throughout the world. From the most congested urban marina, to isolated lakes in wilderness areas, to the severe cold of far off northern seas, and in sunny tropic remote rivers of primitive islands or continents, fiberglass boats can be found performing their daily tasks with a minimum of maintenance.

A fiberglass hull has almost no internal stresses. Therefore, when the hull is broken or stove-in, it retains its true form. It will not dent to take an out-of-shape set. When the hull sustains a severe blow, the impact will be either absorbed by deflection of the laminated panel or the blow will result in a definite, localized break. In addition to hull damage, bulkheads, stringers, and other stiffening structures attached to the hull may also be affected and therefore, should be checked. Repairs are usually confined to the general area of the rupture.



Example of a fouled boat bottom and lower outboard unit. Such a condition should be corrected in order to obtain maximum performance from the boat and power plant.

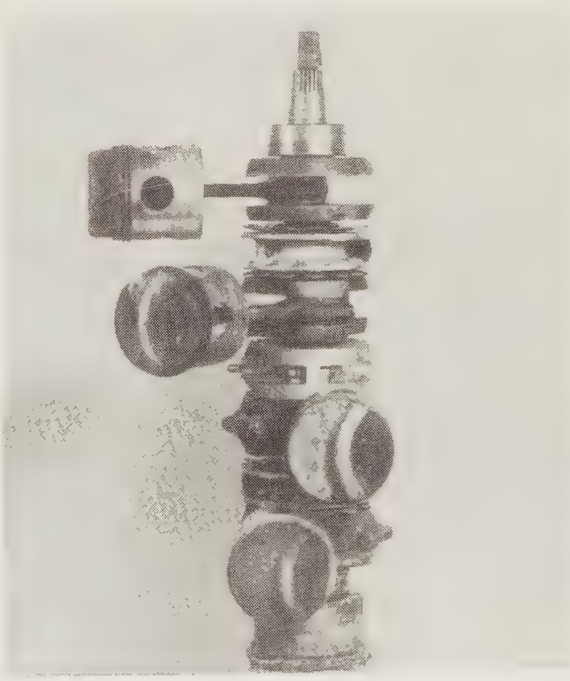
3-6 BELOW WATERLINE SERVICE

A foul bottom can seriously affect boat performance. This is one reason why racers, large and small, both powerboat and sail, are constantly giving attention to the condition of the hull below the waterline.

In areas where marine growth is prevalent, a coating of vinyl, anti-fouling bottom paint should be applied. If growth has developed on the bottom, it can be removed with a solution of muriatic acid applied with a brush or swab and then rinsed with clear water. **ALWAYS** use rubber gloves when working with muriatic acid and **TAKE EXTRA CARE** to keep it away from your face and hands. The **FUMES ARE TOXIC.** Therefore, work in a well-ventilated area, or if outside, keep your face on the windward side of the work.

Barnacles have a nasty habit of making their home on the bottom of boats which have not been treated with anti-fouling paint. Actually they will not harm the fiberglass hull, but can develop into a major nuisance.

If barnacles or other crustaceans have attached themselves to the hull, extra work will be required to bring the bottom back to a satisfactory condition. First, if practical, put the boat into a body of fresh water and



Crankshaft assembly from a submerged 4-cylinder powerhead. All parts visible have been damaged and are unfit for service because the unit was not disassembled immediately after recovery.

allow it to remain for a few days. A large percentage of the growth can be removed in this manner. If this remedy is not possible, wash the bottom thoroughly with a high-pressure fresh water source and use a scraper. Small particles of hard shell may still hold fast. These can be removed with sandpaper.

3-7 SUBMERGED ENGINE SERVICE

A submerged engine is always the result of an unforeseen accident. Once the engine is recovered, special care and service procedures **MUST** be closely followed in order to return the unit to satisfactory performance.

NEVER, again we say **NEVER** allow an engine that has been submerged to stand more than a couple hours before following the procedures outlined in this section and making every effort to get it running. Such delay will result in serious internal damage. If all efforts fail and the engine cannot be started after the following procedures have been performed, the engine should be disassembled, cleaned, assembled, using new gaskets, seals, and O-rings, and then started as soon as possible.

Submerged engine treatment is divided into three unique problem areas: Submersion in salt water; submerged engine while running; and a submerged engine in fresh water, including special instructions.

The most critical of these three circumstances is the engine submerged in salt water, with submersion while running a close second.

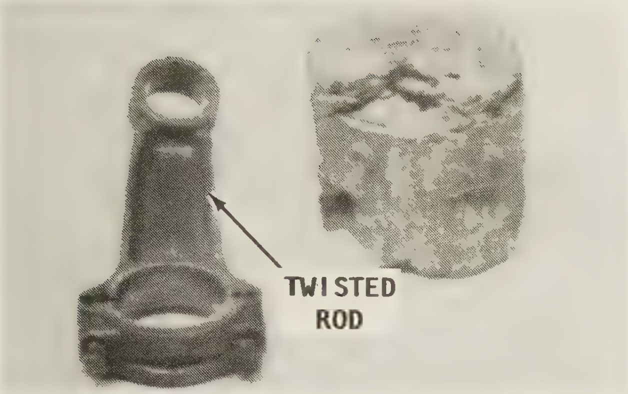
Salt Water Submersion

NEVER attempt to start the engine after it has been recovered. This action will only result in additional parts being damaged and the cost of restoring the engine increased considerably. If the engine was submerged in salt water the complete unit **MUST** be disassembled, cleaned, and assembled with new gaskets, O-rings, and seals. The corrosive effect of salt water can only be eliminated by the complete job being properly performed.

Submerged While Running
Special Instructions

If the engine was running when it was submerged, the chances of internal engine damage is greatly increased. After the engine has been recovered, remove the

Two Quicksilver products available for normal maintenance use and to restore an engine after it has been submerged.



Damaged rod and piston caused when the powerhead was submerged while running.

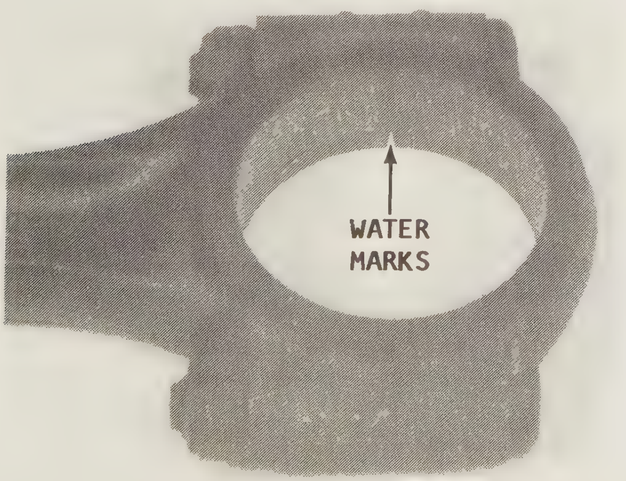
spark plugs to prevent compression in the cylinders. Make an attempt to rotate the crankshaft with the rewind starter or the flywheel. On larger horsepower engines without a rewind starter, use a socket wrench on the flywheel nut to rotate the crankshaft. If the attempt fails, the chances of serious internal damage, such as: bent connecting rod, bent crankshaft, or damaged cylinder, is greatly increased. If the crankshaft cannot be rotated, the powerhead must be completely disassembled.

CRITICAL WORDS

Never attempt to start powerhead that has been submerged. If there is water in the cylinder, the piston will not be able to compress the liquid. The result will most likely be a bent connecting rod.

Submerged Engine — Fresh Water

SPECIAL WORD: As an aid to performing the restoration work, the following steps are numbered and should be followed in sequence. However, illustrations are not included with the procedural steps because the work involved is general in nature.



Damaged rod and rod cap unfit for further service. The needle bearing water marks shown were caused from water entering the powerhead.

1- Recover the outboard unit as quickly as possible.

2- Remove the cowling and the spark plugs.

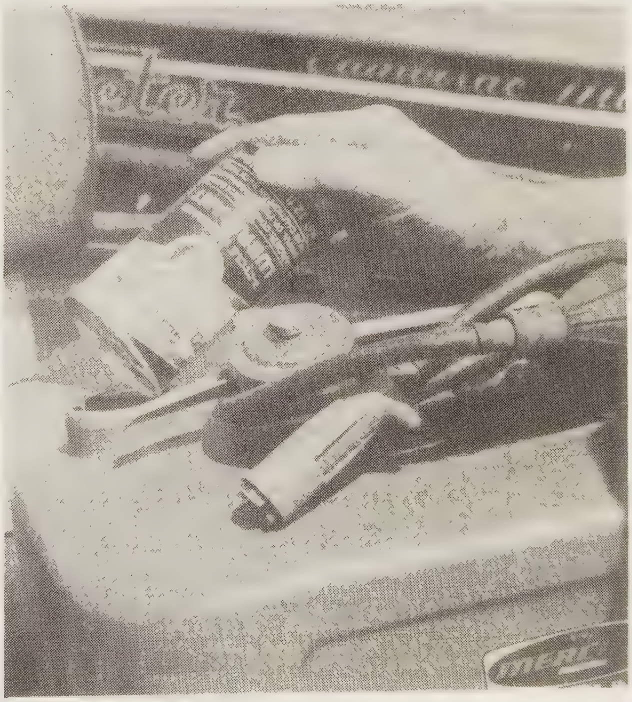
3- Remove the carburetor float bowl cover, or the bowl.

4- Flush the outside of the engine with fresh water to remove silt, mud, sand, weeds, and other debris. **DO NOT** attempt to start the engine if sand has entered the powerhead. Such action will only result in serious damage to powerhead components. Sand in the powerhead means the unit must be disassembled.

CRITICAL WORDS

Never attempt to start powerhead that has been submerged. If there is water in the cylinder, the piston will not be able to compress the liquid. The result will most likely be a bent connecting rod.

5- Remove as much water as possible from the powerhead. Most of the water can be eliminated by first holding the engine in a horizontal position with the spark plug



If an outboard has been submerged and recovered quickly -- then the powerhead serviced according to instruction in the text, without delay, it can be started. A special fuel/oil ratio of 50:1 should be used to ensure adequate lubrication. A separate fuel tank, as the one shown, will prove very handy for this special operation.

holes **DOWN**, and then cranking the powerhead with the rewind starter or with a socket wrench on the flywheel nut. Rotate the crankshaft through at least 10 complete revolutions. If you are satisfied there is no water in the cylinders, proceed with Step 6 to remove moisture.

6- Alcohol will absorb moisture. Therefore, pour alcohol into the carburetor throat and again crank the powerhead.

7- Rotate the outboard in the horizontal position until the spark plug openings are facing **UPWARD.** Pour alcohol into the spark plug openings and again rotate the crankshaft.

8- Rotate the outboard in the horizontal position until the spark plug openings are again facing **DOWN.** Pour engine oil into the carburetor throat and, at the same time, rotate the crankshaft to distribute oil throughout the crankcase.

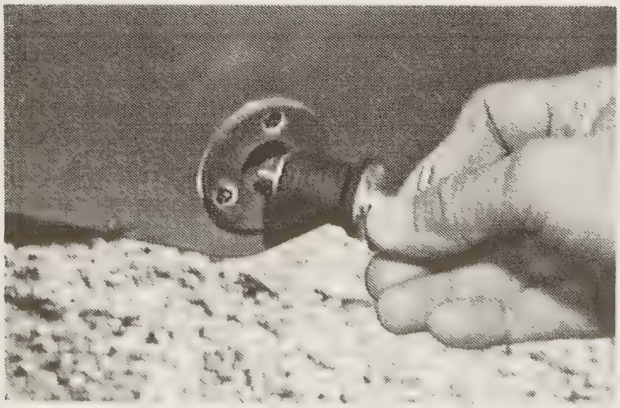
9- Rotate the outboard in the horizontal position until the spark plug holes are again facing **UPWARD.** Pour approximately one teaspoon of engine oil into each spark plug opening. Rotate the crankshaft to distribute the oil in the cylinders.

10- Install and connect the spark plugs.

11- Install the carburetor float bowl cover, or the bowl.

12- Obtain **FRESH** fuel and attempt to start the engine. If the powerhead will start, allow it to run for approximately an hour to eliminate any unwanted moisture remaining in the powerhead.

CAUTION: Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.



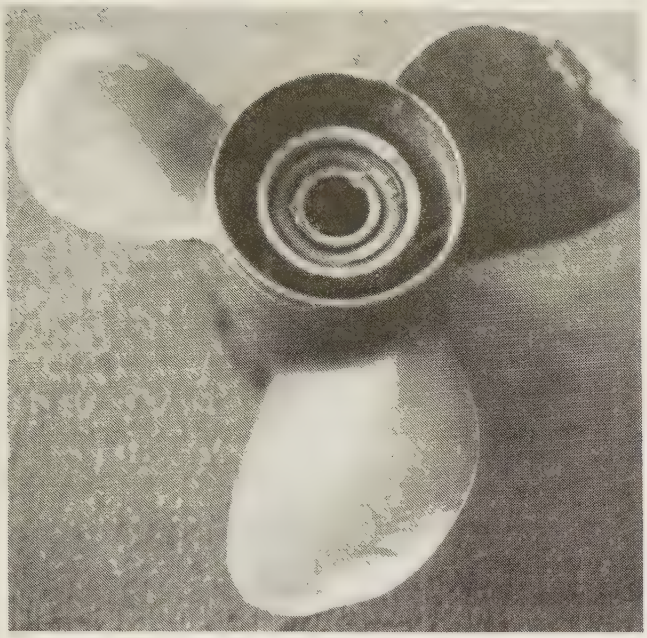
The membership of the fraternity of boat owners failing to install the drain plug before launching increases every year.

13- If the powerhead fails to start, determine the cause, electrical or fuel, correct the problem, and again attempt to get it running. **NEVER** allow a powerhead to remain unstarted for more than a couple hours without following the procedures in this section and attempting to start it. If attempts to start the powerhead fail, the unit should be disassembled, cleaned, assembled, using new gaskets, seals, and O-rings, just as **SOON** as possible.

3-8 PROPELLER SERVICE

The propeller should be checked regularly to be sure all the blades are in good condition. If any of the blades become bent or nicked, this condition will set up vibrations in the motor. Remove and inspect the propeller. Use a file to trim nicks and burrs. **TAKE CARE** not to remove any more material than is absolutely necessary. For a complete check, take the propeller to your marine dealer where the proper equipment and knowledgeable mechanics are available to perform a proper job at modest cost.

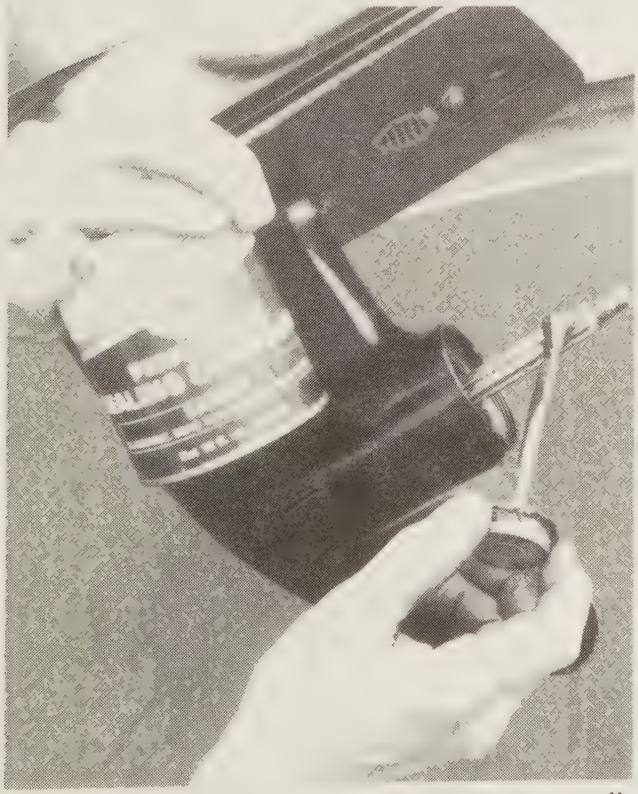
Excellent view of rope and fish line entangled behind the propeller. Entangled fish line can actually cut through the seals, allowing water to enter and oil to escape the lower unit.



This slightly damaged propeller can be reconditioned in a "Prop Shop", and then returned to service.

Inspect the propeller shaft to be sure it is still true and not bent. If the shaft is not perfectly true, it should be replaced.

Install the thrust hub. Coat the propeller shaft splines with Perfect Seal No. 4, and the rest of the shaft with a good grade of anti-corrosion lubricant. Install the propeller, and then the splined washer, tab washer, and propeller nut.



Applying Perfect Seal compound to the propeller shaft. This compound should be used each and every time the propeller is removed to prevent the propeller from "freezing" onto the propeller shaft.

Damage was caused to this unit when the propeller struck an underwater object. If the propeller should suffer this much abuse, the propeller shaft should be carefully checked.

Position a block of wood between the propeller and the anti-cavitation tab to keep the propeller from rotating. Tighten the propeller nut to a torque value of 55 ft lbs (75Nm). Adjust the nut to fit the tab lock space. Bend three of the tab washer tabs into the splined washer using a punch and hammer. The tabs will prevent the nut from backing out.

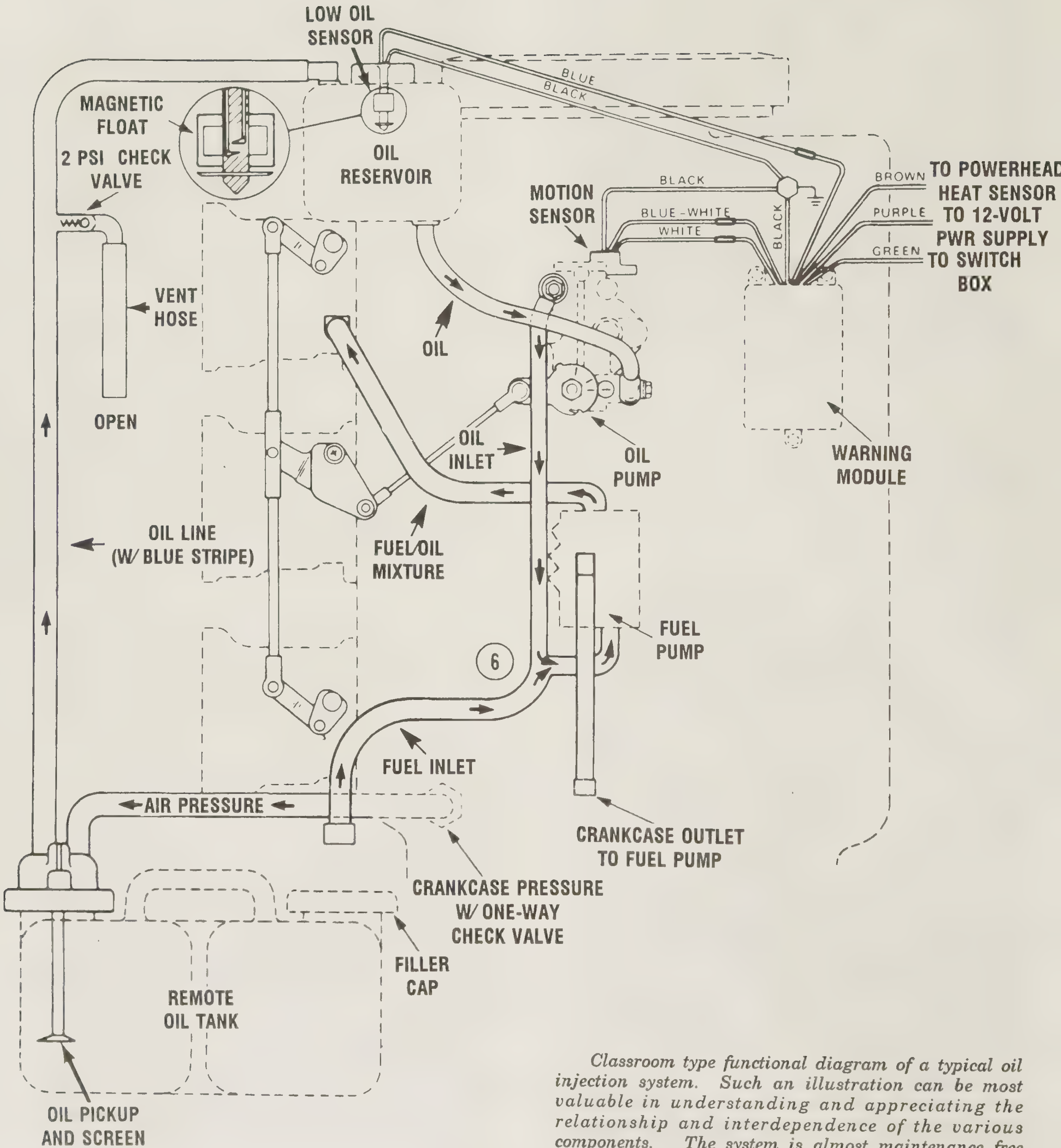
3-9 POWER TRIM/TILT

Check the power trim and tilt system for proper operation. **BE SURE** the battery is fully charged before operating the trim/tilt system. Check the fluid level in the trim/tilt system.

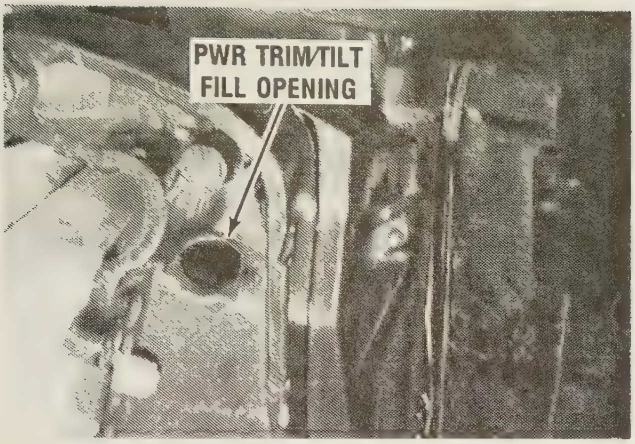
Fluid Level Check - All Transom Mounted Trim/Tilt Systems

Raise the outboard unit to the full **UP or TILT** position, then **ENGAGE** the uplock lever. Slowly remove the **FILL PLUG** from the port side of the transom bracket, or the center of the reservoir -- depending on the model being serviced. Fluid level should be visible in the fill tube on the transom bracket models and up to the fill plug on reservoir models. If necessary add Quicksilver Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) Type F, FA or Dexron II. Do not overfill. See Chapter 10 for detailed instructions to bleed and flush the system. Install the **FILL PLUG** and securely tighten.

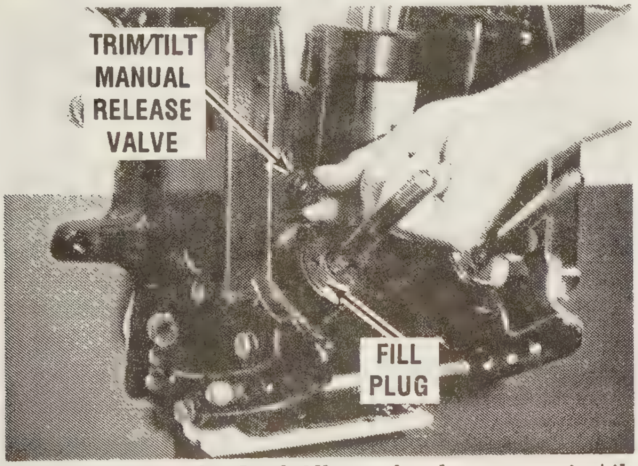
If fluid level was extremely low, cycle the outboard unit from full up to full down two times, and recheck the fluid level once again.



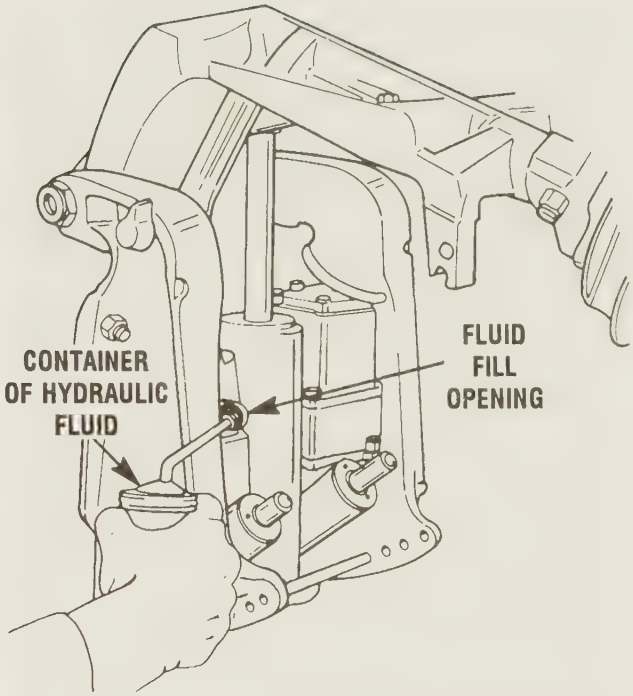
Classroom type functional diagram of a typical oil injection system. Such an illustration can be most valuable in understanding and appreciating the relationship and interdependence of the various components. The system is almost maintenance free except for filling the remote oil tank, checking movement of the low oil warning device in the reservoir mounted on the powerhead and giving just a drop of lubricant to the linkage joints -- say once each season.



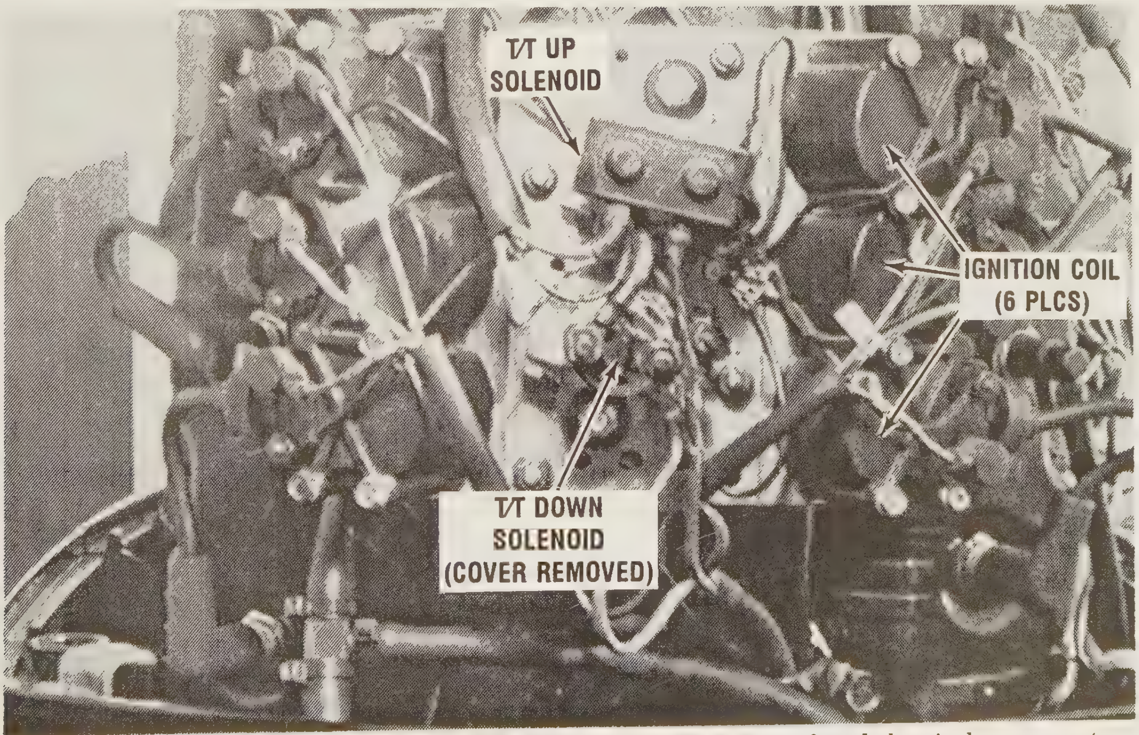
Location of the fill opening for the power trim/tilt system installed on the units covered in this manual.



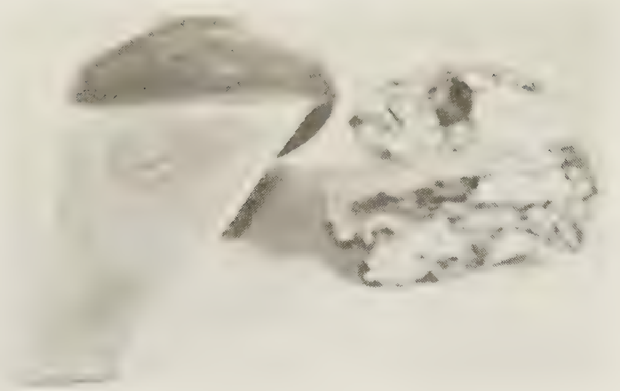
*Location of the fluid fill cap for the power trim/tilt System "**A**".*



*Line drawing to depict location of the fill opening on one model trim/tilt System "**B**" unit with two trim cyinders and a single tilt cylinder. Another model of the same system utilized a fill tube -- covered in Chapter 10.*



Once the powerhead cowling is removed, a host of mechanical and electrical components are exposed -- port, starboard, fore and aft -- for maintenance, testing, service, or replacement tasks.



A new trim tab (left), and a badly deteriorated tab (right). Actually, such extensive erosion of the tab suggests a possible electrolysis problem.

Trim Tabs

Check the trim tab and the anodic heads. Replace them, if necessary. The trim tab must make a good ground inside the lower unit. Therefore, the trim tab and the cavity **MUST NOT** be painted. In addition to trimming the boat, the trim tab acts as a zinc electrode to prevent electrolysis from acting on more expensive parts. It is normal for the tab to show signs of erosion. The tabs are inexpensive and should be replaced frequently.

Clean the exterior surface of the unit thoroughly. Inspect the finish for damage or corrosion. Clean any damaged or corroded areas, and then apply primer and matching paint.

Check the entire unit for loose, damaged, or missing parts.

Two types of trim tab used on the outboard units covered in this manual.

3-10 INSIDE THE BOAT

The following points may be lubricated with Quicksilver Multipurpose Lubricant:

a– Ride-Guide steering cable end next to the hand nut. **DO NOT** over-lubricate the cable.

b– Steering arm pivot socket.

c– Exposed shaft of the cable passing through the cable guide tube.

d– Steering link rod to the steering cable.

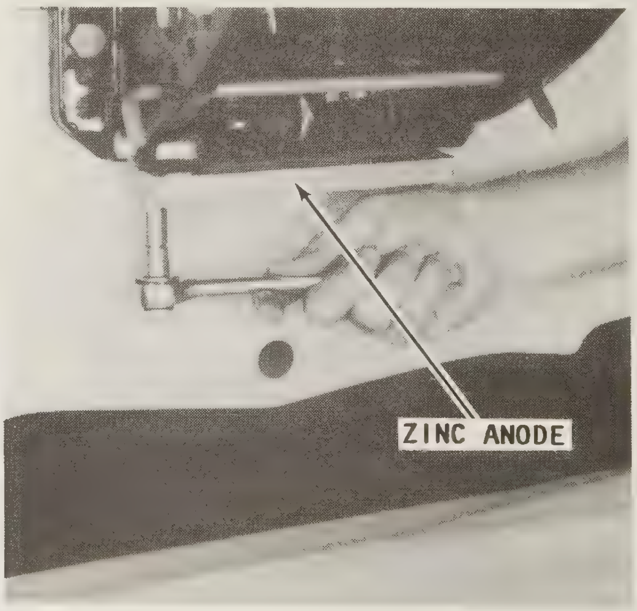
3-11 LOWER UNIT

Draining Lower Unit

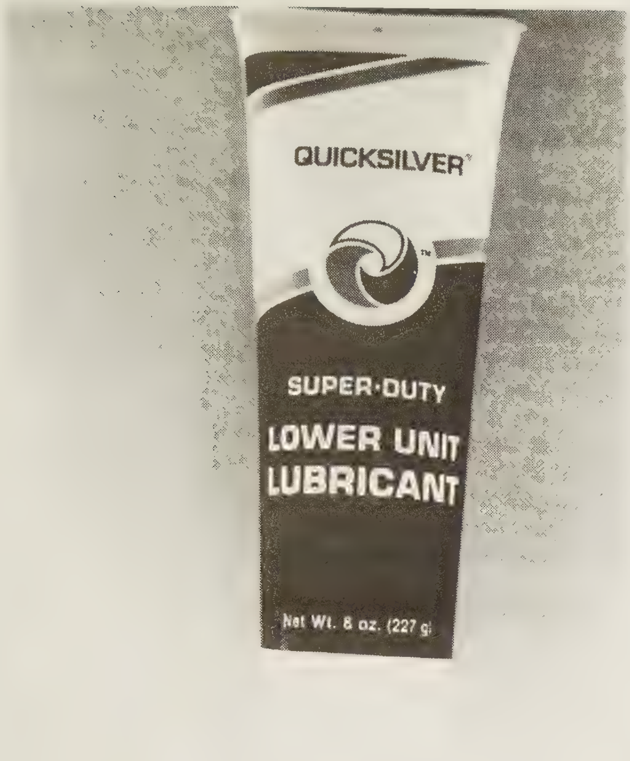
Remove the **FILL** plug from the lower end of the gear housing on the port side and the **VENT** plug just above the anti-cavitation plate.

NEVER remove the vent or filler plugs when the drive unit is hot. Expanded lubricant would be released through the plug hole. Check the lubricant level after the unit has been allowed to cool. Add only Super-Duty Gear Lubricant. **NEVER** use regular automotive-type grease in the lower unit because it expands and foams too much. Lower units do not have provisions to accommodate such expansion.

If the lubricant appears milky brown, or if large amounts of lubricant must be added to bring the lubricant up to the full mark, a thorough check should be made to determine the cause of the loss.

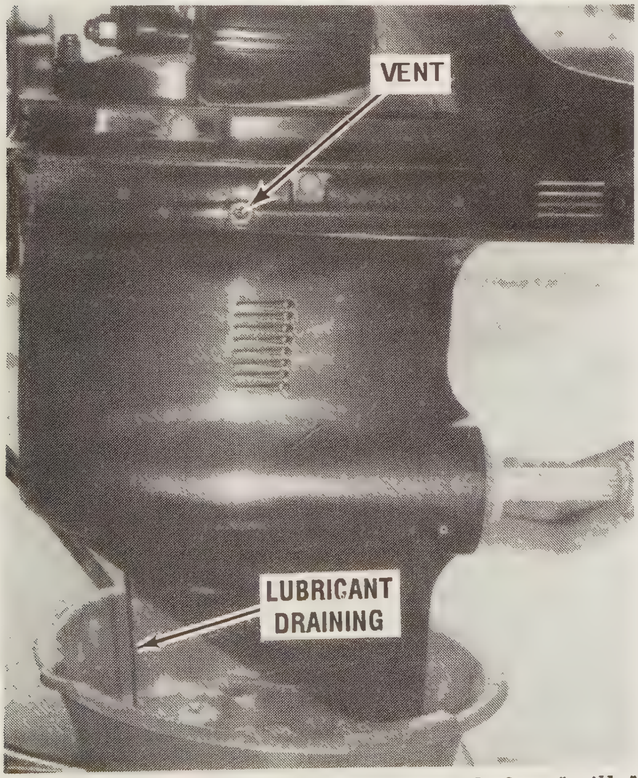


A new zinc anode being installed on the underside of the trim/tilt unit, to provide corrosion protection.

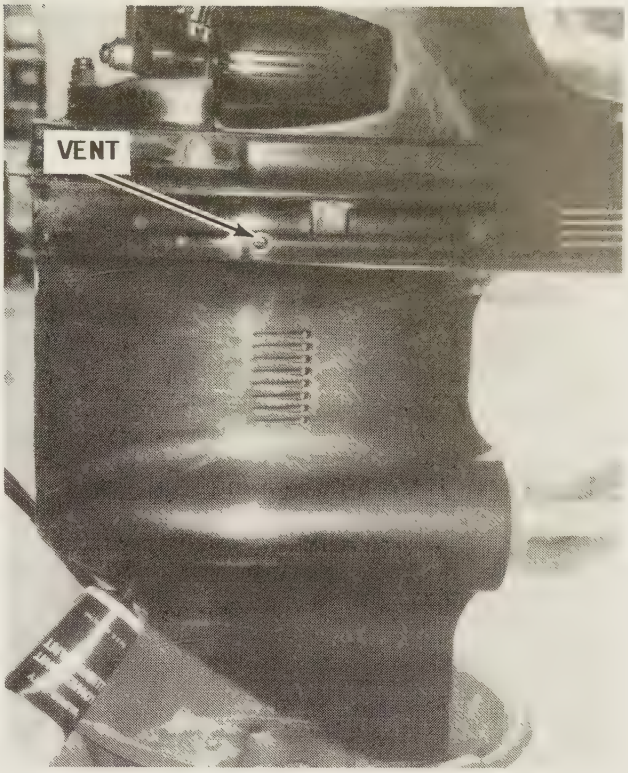


*Approved lower unit lubricant. To protect the investment made in the outboard purchase, **ONLY** the very best products should be used. The small added cost is worth the increased expense many times over.*

Because the trim/tilt is considered a "closed" system, loss of fluid is almost always due to a loose connection or fitting.



*While draining lubricant, watch closely for a "milky" color indicating water in the lower unit. **BAD NEWS!***

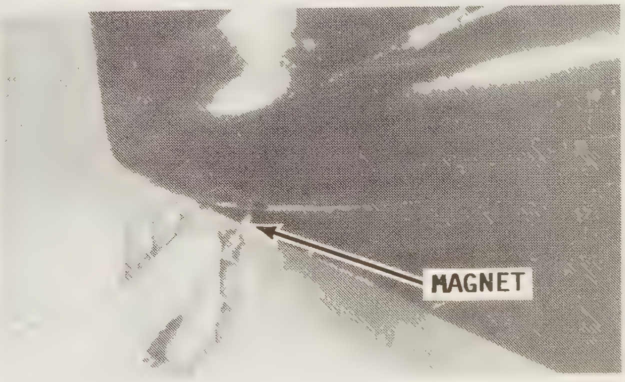


Filling the lower unit with approved lower unit lubricant. Be sure the vent screw has been removed.

Filling Lower Unit

Position the drive unit approximately vertical and without a list to either port or starboard. Insert the lubricant tube into the **FILL/DRAIN** hole at the bottom plug hole, and inject lubricant until the excess begins to come out the **VENT** hole. Install the **VENT** and **FILL** plugs with **NEW** gaskets. Check to be sure the gaskets are properly positioned to prevent water from entering the housing.

See the Appendix for lower unit capacities.



Installing the drain plug into the lower unit. New drain plugs have an integral magnet to catch metal particles in the lubricant. The new plug should be purchased and installed the next time the lower unit lubricant is changed.

3-12 WINTER STORAGE

Taking extra time to store the boat properly at the end of each season, will increase the chances of satisfactory service at the next season. **REMEMBER,** idleness is the greatest enemy of an outboard motor. The unit should be run on a monthly basis. The boat steering and shifting mechanism should also be worked through complete cycles several times each month. The owner who spends a small amount of time involved in such maintenance will be rewarded by satisfactory performance, and greatly reduced maintenance expense for parts and labor.

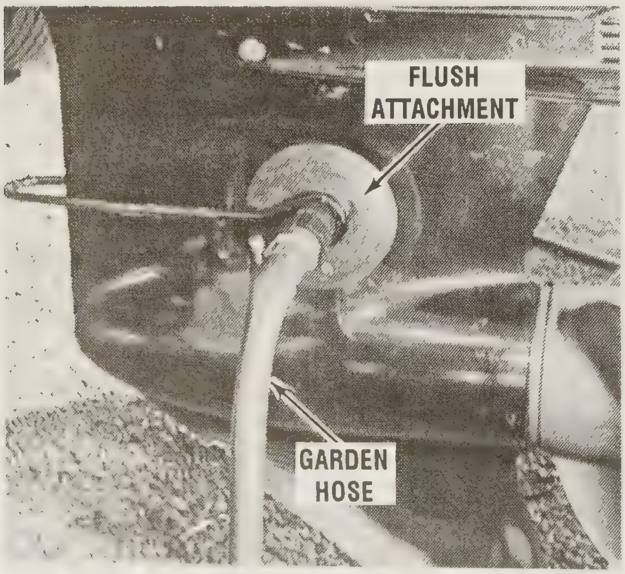
Proper storage involves adequate protection of the unit from physical damage, rust, corrosion, and dirt.

Taking a few minutes extra time at the end of a season will greatly enhance the chances the unit will be ready for action, next time.

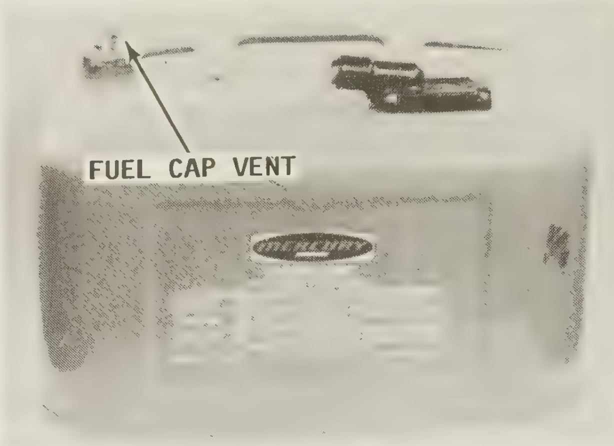
The following steps provide an adequate maintenance program for storing the unit at the end of a season.

1- Remove the cowling. Start the powerhead and allow it to warm to operating temperature.

CAUTION: Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.



*When a flush attachment and garden hose are connected to the lower unit, the powerhead should **NEVER** be operated above idle rpm and the unit **MUST** remain in NEUTRAL.*



The fuel tank should be drained and stored in a cool dry area with the vent open to allow air to circulate through the tank during the off-season.

Disconnect the fuel line from the engine and allow the unit to run at **LOW** rpm and, at the same time, inject about 4 ounces of Quicksilver Storage Seal through each carburetor throat. Allow the engine to run until it shuts down from lack of fuel, indicating the caburetors are dry of fuel.

2- Drain the fuel tank and the fuel lines. Pour approximately one quart (0.96 liters) of an approved cleaning solution -- available at the marine dealer -- into the fuel tank, and then rinse the tank and pickup filter with the solution. Drain the tank. Store the fuel tank in a cool dry area with the vent **OPEN** to allow air to

Every boat owner should have a can of Perfect Seal Sealing Compound ready for use when installing the propeller. This product will prevent the propeller splines seizing with the propeller shaft splines.

circulate through the tank. **DO NOT** store the fuel tank on a bare concrete floor. Place the tank in position to allow air to circulate around it.

3- Drain, and then fill the lower unit with Super-Duty Lower Unit Gear Lubricant, as outlined in Section 3-11.

4- Lubricate the throttle and shift linkage. Lubricate the swivel pin and the tilt tube with Multi-purpose Lubricant, or equivalent.

5- Clean the outboard unit thoroughly. Coat the powerhead with Corrosion and Rust Preventative spray. Install the cowling, and then apply a thin film of fresh engine oil to all painted surfaces.

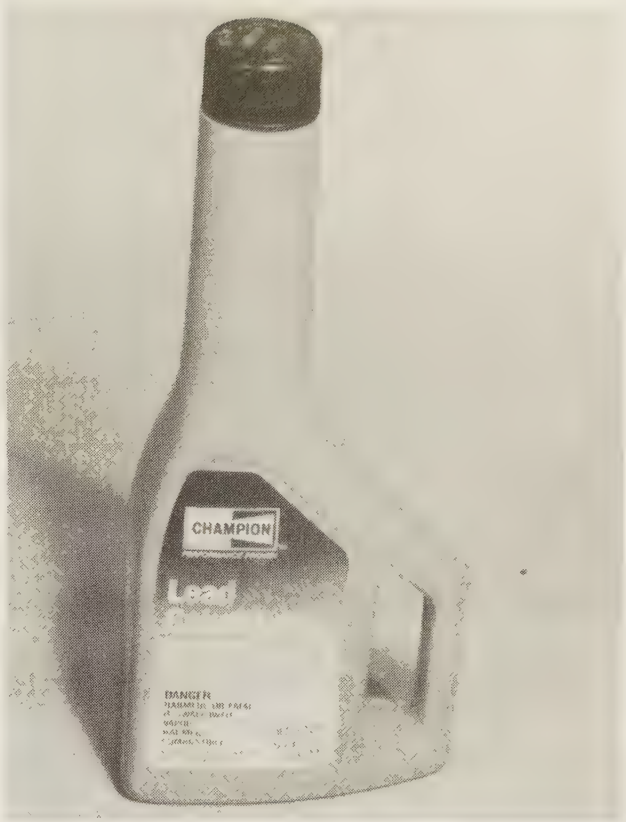
6- Remove the propeller. Apply Perfect Seal or a waterproof sealer to the propeller shaft splines, and then install the propeller back in position.

Install the front cover by aligning the cover openings on both sides of the unit, and then pushing in on the cover until it snaps into place.

Oil may remain in the oil injection tank during storage without any harmful effects.

FINAL WORDS: Be sure all drain holes in the gear housing are open and free of obstruction. Check to be sure the **FLUSH** plug has been removed to allow all water to drain. Trapped water could freeze, expand, and cause expensive castings to crack.

ALWAYS store the outboard unit off the boat with the lower unit below the powerhead to prevent any water from being trapped inside.



A lead substitute additive can help prevent detonation when unleaded gasoline is used for an outboard fuel.

BATTERY STORAGE

Remove the batteries from the boat and keep them charged during the storage period. Clean the batteries thoroughly of any dirt or corrosion, and then charge them to full specific gravity reading. After they are

Manufacturer recommended lubricants and additives will not only keep the unit within the limits of the warranty, but will be a major contributing factor to dependable performance and reduced maintenance costs.

fully charged, store them in a clean cool dry place where they will not be damaged or knocked over.

NEVER store the battery with anything on top of it or cover the battery in such a manner as to prevent air from circulating around the fillercaps. All batteries, both new and old, will discharge during periods of storage, more so if they are hot than if they remain cool. Therefore, the electrolyte level and the specific gravity should be checked at regular intervals. A drop in the specific gravity reading is cause to charge them back to a full reading.

In cold climates, **EXERCISE CARE** in selecting the battery storage area. A fully-charged battery will freeze at about 60 degrees below zero. A discharged battery, almost dead, will have ice forming at about 19 degrees above zero.

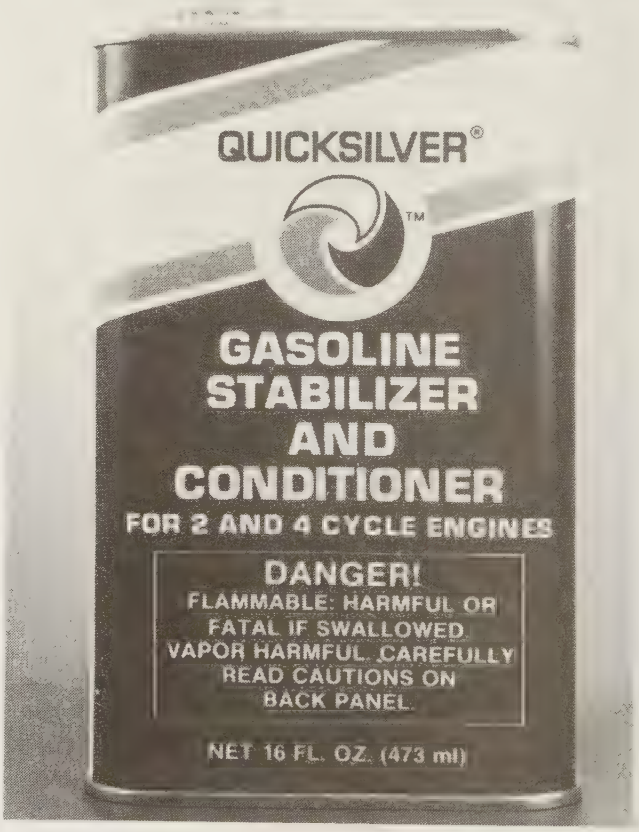
ALWAYS remove the drain plug and position the boat with the bow higher than the stern. This will allow any rain water and melted snow to drain from the boat and prevent "trailer sinking". This term is used to describe a boat that has filled with rain water and ruined the interior, because the plug was not removed or the bow was not high enough to allow the water to drain properly.

Manufacturer's approved paint products to dress the outboard unit and give a special "pride of ownership" look. After the paint (left), is used, the leveler (right) can be applied for a smooth professional finish.

ONE FINAL WORD

Let us say again: Before putting the boat in the water, take time to verify the drain plug is installed. One good way to safeguard against forgetting the plug is to tie the plug to the steering wheel the moment it is removed for storage or the trip home on a trailer.

Keep the shift shaft shifting, the trim tab trimmed, the fuel pump pumping, the spark plugs sparking, and the pistons -- well, keep them working too.



Quicksilver Gasoline Stabilizer and Conditioner may be used to prevent the fuel from "souring" for up to twelve full months.

4
FUEL

4-1 INTRODUCTION

The carburetion, fuel injection and ignition principles of two-cycle engine operation **MUST** be understood in order to perform a proper tune-up on an outboard powerhead.

If you have any doubts concerning an understanding of two-cycle engine operation, it would be best to study the Introduction section in the first portion of Chapter 8, before tackling any work on the fuel system.

On all V6 model powerheads, **EXCEPT** units equipped with electronic fuel injection (EFI), the fuel system includes the fuel tank, fuel pump, fuel filters, an anti-syphon valve, carburetors, a squeeze bulb, and the associated parts to connect it all together. Regular maintenance of the fuel system to obtain maximum performance, is limited to changing the fuel filter at regular intervals and using fresh fuel.

Some V6 powerheads are equipped with state-of-the-art Electronic Fuel Injection (EFI). This fuel distribution system is computer controlled. Five different sensors provide the computer with information on powerhead rpm, throttle setting, manifold air temperature, powerhead temperature and manifold pressure -- which automatically adjusts to barometric pressure. A detonation sensor and detonation controller are installed on the Model 200hp **ONLY.**

The EFI fuel system includes the fuel tank, an anti-syphon valve, a mechanical fuel pump, water separation filter, an electric "booster" fuel pump, a primary fuel filter, a secondary fuel filter, a vapor separator, a fuel pressure regulator, and an injector fuel rail supporting six fuel injectors -- each a mini solenoid -- five sensors, and an Electronic Control Unit (ECU) -- a "black box" -- meaning it cannot be opened.

CHAPTER COVERAGE

Section **4-2** thru and including **4-8** apply to all powerhead models **EXCEPT** powerheads with EFI.

Sections **4-9** thru **4-11** apply **ONLY** to V6 powerheads equipped with EFI.

Because the EFI system is so different from a carburetor fuel system, the following sections apply to only one system, with one exception. The section covering the fuel pump operated by crankcase vacuum applies to both the carburetor system and the EFI system.

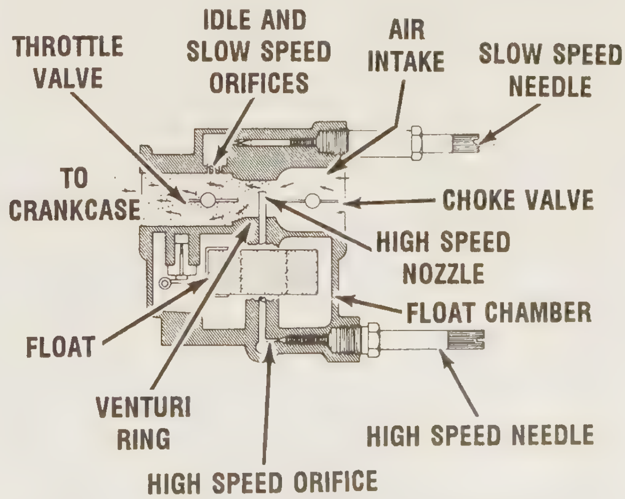
All V6 units in this manual are equipped with oil injection. Therefore, Section **4-12** applies to all powerheads.

4-2 GENERAL INFORMATION ALL MODELS EQUIPPED WITH CARBURETION

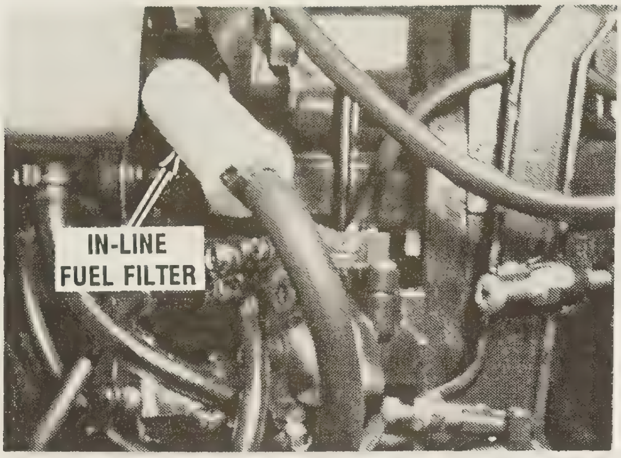
The carburetor is merely a metering device for mixing fuel and air in the proper proportions for efficient engine operation. At idle speed, an outboard engine requires a mixture of about 8 parts air to 1 part fuel. At high speed or under heavy duty service, the mixture may change to as much as 12 parts air to 1 part fuel.

Float Systems

A small chamber in the carburetor serves as a fuel reservoir. A float valve



Line drawing to show fuel flow through the venturi of a typical carburetor with principle and related parts controlling intake and outflow identified.



Typical in-line fuel filter installation on a V6 powerhead.

admits fuel into the reservoir to replace the fuel consumed by the engine. If the carburetor has more than one reservoir, the fuel level in each reservoir (chamber) is controlled by identical float systems.

Fuel level in each chamber is extremely critical and must be maintained accurately. Accuracy is obtained through proper adjustment of the floats. This adjustment will provide a balanced metering of fuel to each cylinder at all speeds.

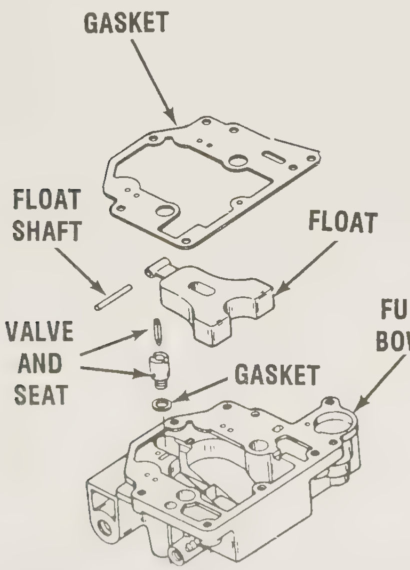
Following the fuel through its course, from the fuel tank to the combustion chamber of the cylinder, will provide an appreciation of exactly what is taking place. In order to start the engine, the fuel must be moved from the tank to the carburetor by a squeeze bulb installed in the fuel line. This action is necessary because the fuel pump does not have sufficient pressure to draw fuel from the tank during cranking before the engine starts.

After the powerhead starts, fuel is drawn from the fuel tank by a crankcase-pressure operated fuel pump. All carburetor V-6 fuel systems have an in-line fuel filter installed between the fuel pump and the top carburetor.

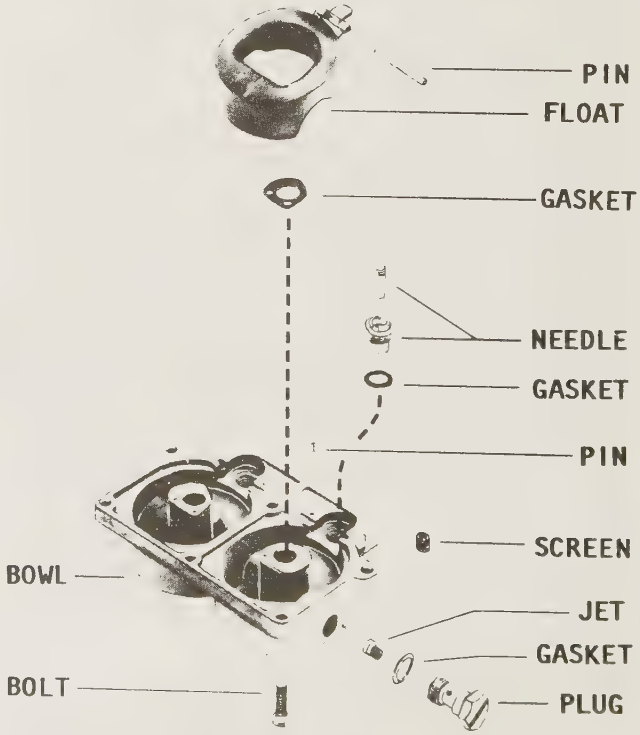
Oil, from the oil injection pump is mixed with the fuel just prior to the fuel entering the fuel pump.

At the carburetor, the fuel passes through the inlet passage to the needle and seat, and then into the float chamber (reservoir). A float in the chamber rides up and down on the surface of the fuel. After fuel enters the chamber and the level rises to a predetermined point, a tang on the float closes the inlet needle and the flow entering the chamber is cutoff. When fuel leaves the chamber as the engine operates, the fuel level drops and the float tang allows the inlet needle to move off its seat and fuel once again enters the chamber. In this manner a constant reservoir of fuel is maintained in the chamber to satisfy the demands of the engine at all speeds.

A fuel chamber vent hole is located near the top of the carburetor body to permit atmospheric pressure to act against the fuel



Exploded view of a single float system.



Exploded view of a double float system carburetor.

in each chamber. This pressure assures an adequate fuel supply to the various operating systems of the engine.

Air/Fuel Mixture

A suction effect is created each time the piston moves upward in the cylinder. This suction draws air through the throat of the carburetor. A restriction in the throat, called a venturi, controls air velocity and has the effect of reducing air pressure at this point.

The difference in air pressures at the throat and in the fuel chamber, causes the fuel to be pushed out of metering jets extending down into the fuel chamber. When the fuel leaves the jets, it mixes with the air passing through the venturi. This fuel/air mixture should then be in the proper proportion for burning in the cylinders for maximum engine performance.

In order to obtain the proper air/fuel mixture for all engine speeds, high and low speed jets are provided. These jets have adjustable needle valves which are used to compensate for changing atmospheric conditions. In almost all cases, the high-speed circuit has fixed high-speed jets that are not adjustable.

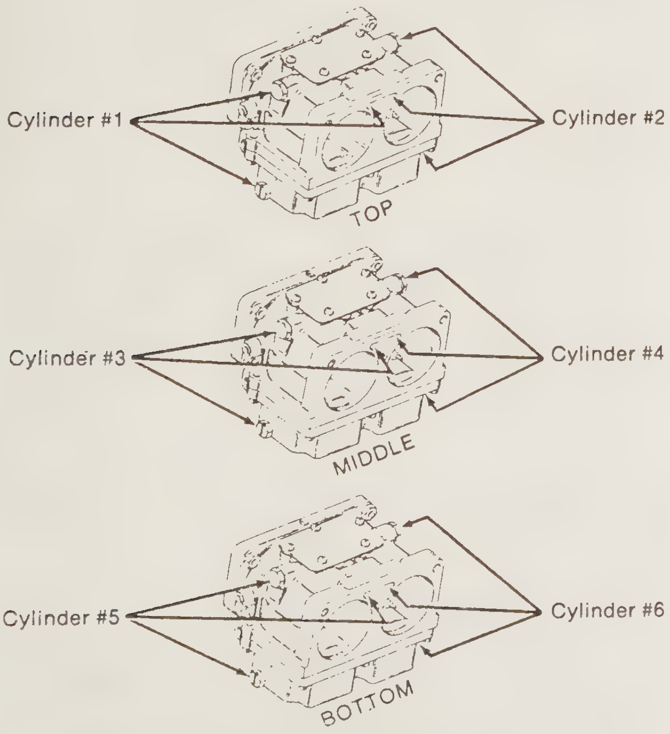
CARBURETOR IDENTIFICATION

At press time, all carburetors installed on the powerheads covered in this manual were three different versions of the Walbro WMH. For ease of identification and reference, the carburetors have been assigned letter designations, "**A**", "**B**" and "**C**".

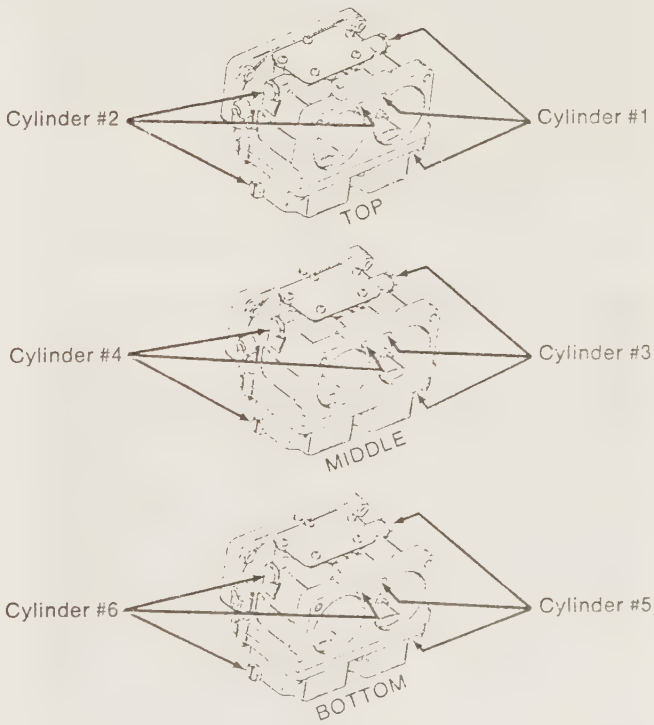
Carburetor "**A**" -- Walbro WH -- with two barrels and two floats is installed on Model 135hp thru 200hp -- 1990 **ONLY.**

Carburetor "**B**" -- Walbro WMH -- two barrels and only one float, has been installed on Model 135hp thru 225hp since 1991. The 1991 carburetor had an accelerator pump. After 1991, the pump circuit was no longer used and the opening for the pump was merely sealed with a plug.

Carburetor "**C**" -- Walbro WO -- with a single barrel and a dual float in a single bowl has been installed -- on the Model 275hp powerhead since 1990. Six units serve the powerhead -- one for each cylinder.



*Simple drawing to depict Carburetor "**A**" or "**B**" jet delivery to designated cylinders for the Model 135 thru 175hp -- 1990 **ONLY** with vertical reeds installed.*



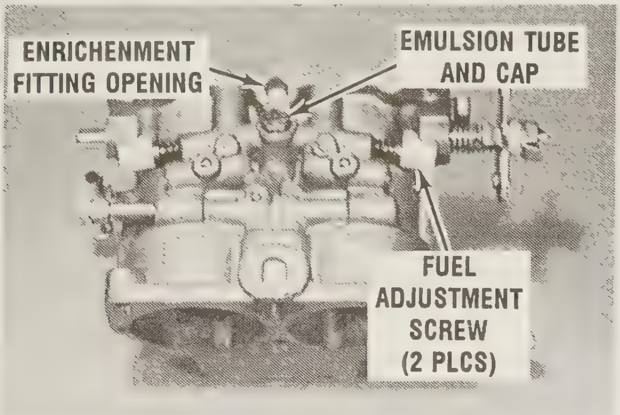
*Simple drawing to depict Carburetor "**A**" or "**B**" jet delivery to designated cylinders for the Model 135 thru 225hp -- 1990 and on with horizontal reeds installed.*

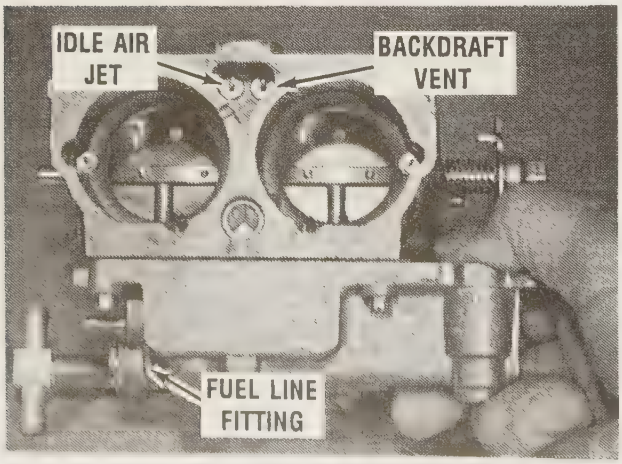
Carburetor Jets
Model Year 1990 Only

Model 135hp thru 200hp are equipped with an early version of the Walbro WMH carburetor. These carburetors are provided with three sets of jets, as shown in the accompanying illustration for carburetor "**A**". The three sets of changeable jets include two Main -- High Speed -- Jets, two Vent Jets and two Idle Air Jets. Idle speed fuel mixture is not adjustable on this model carburetor. In order to change the fuel mixture, the size of the Idle Air Jet must changed.

Carburetor Jets Model
Year 1991 And On

Model 135hp thru 225hp are equipped with a later model of the Walbro WMH carburetor. These newer carburetors are provided with; 2-Off Idle Jets, two Main -- High Speed --Jets, one Idle Air Bleed Jet, one Back Draft Jet and two Adjustable Idle Mixture Screws, as shown in the two accompanying illustrations for carburetor "**B**". Two, Idle Speed Mixture screws are provided for changing the idle speed fuel mixture.





Two views of Carburetor "B" -- Walbro WMH -- to show principle replaceable jets and fittings.

Main -- High Speed -- Jets
All Models

The main jets, located on each side of the carburetor fuel bowl, control the high speed air/fuel mixture. Fuel is drawn from the fuel bowl, through the main jets. A set of discharge tubes guide the fuel into the carburetor venturi. A jet with a small orifice will provide a lean air/fuel mixture. A jet with a larger orifice will provide a rich air/fuel mixture.

Vent Jets
Carburetor "A"
1990 Only

The vent jets, located at the carburetor throat, lower atmospheric pressure at the fuel bowl, resulting in improved fuel economy. As with the main jets, the smaller the orifice -- the leaner the mixture; the larger the orifice -- the richer the mixture. On some V6 models, the manufacturer calls for different size vent jets for the center and bottom carburetor from those recommended for the top carburetor. The manufacturer takes one further step by calling for different size jets on the starboard and port sides of the carburetor. Check the Jet Size Chart in the Appendix very **CAREFULLY.**

Idle Jets
Carburetor "A"
1990 Only

The set of idle jets, located on either side of the mixing chamber cover, meter air flow. Their operating principle is opposite to the main and vent jets. The smaller the orifice -- the richer the mixture; the larger the orifice -- the leaner the mixture.

Back Draft Jets
Carburetor "A"
1991 And On

The back draft circuit consists of a vent jet which supplies less than atmospheric pressure to the fuel bowl during mid-range power settings. The lower atmospheric pressure in the fuel bowl during mid-range power operation causes the fuel flow to become slightly lean and results in improved performance and fuel economy.

Off-Idle Progression Jet
Carburetor "B"

The off-idle jet is located in each carburetor bore. Each venturi has one off-idle tube and one off-idle air jet. This circuit provides metered fuel during powerhead operation above idle speeds to full throttle operation. If a jet with a smaller orifice is installed, the fuel ration becomes richer. If a jet with a larger orifice is installed, the fuel/air ration becomes leaner.

Idle Circuit Operation
Carburetor "B"

The idle circuit consists of two externally adjustable fuel mixture screws, idle air bleed jet, and factory set air trim screws located beneath welch plugs. The idle circuit operates independently of the progression and main jet circuits.

The two fuel mixture screws provide a maintenance capability of lean or richen the idle fuel mixture for a smoother idle speed. The screws have a limiter cap installed, from the factory, to limit the adjustments to 1/2 turn. When adjusting the fuel mixture screws all screws **MUST** be turned the same amount and in the same direction for the engine to operate efficiently at idle speeds. Turning the screws **CLOCKWISE** will lean the fuel mixture and turning them **COUNTERCLOCKWISE** will richen the fuel mixture. Do not remove the limiter caps to further richen or lean the fuel mixture. If the limiter caps and fuel mixture screws are removed for carburetor cleaning, count the number of turns clockwise (in) until the screw is lightly seated and then remove the screws.

The idle air bleed jet meters air and is located next to the back draft vent jet. If a jet with a smaller orifice is installed the idle fuel/air mixture becomes richer, if a jet with a larger orifice is installed, idle fuel/air ratio becomes leaner.

The two air trim screws are located beneath welch plugs and are preset at the factory. The manufacturer recommends these welch plugs and air trim screws **NOT** be removed.

Fuel Flow Through
Carburetor and Reed Block

If two cylinders of the powerhead share a common carburetor, and the powerhead is equipped with vertically mounted reed blocks, the jets installed on the starboard side of the carburetor supply fuel to the **STARBOARD** cylinder. Likewise, the jets on the port side supply fuel to the **PORT** cylinder.

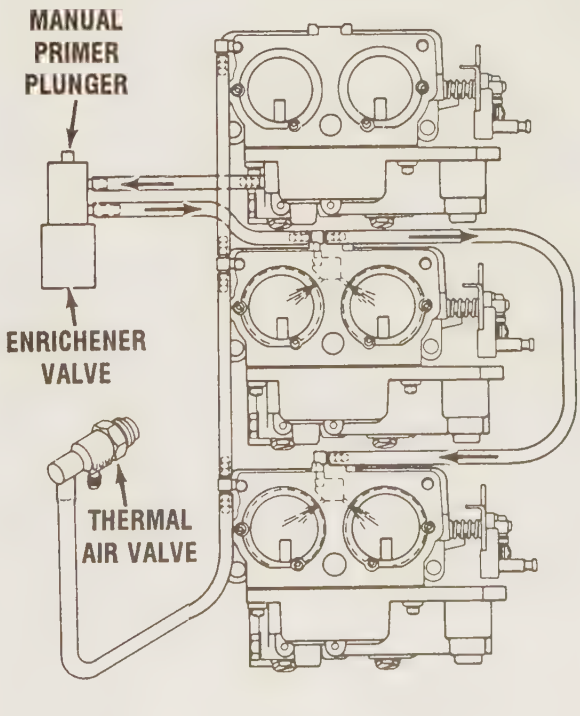
If the powerhead is equipped with horizontal reed blocks, the jets installed on the starboard side of the carburetor supply fuel to the **PORT** cylinder; the jets installed on the port side supply fuel to the **STARBOARD** cylinder.

Powerhead operation at sea level compared with performance at high altitudes is quite noticeable. A jet/altitude chart is provided in the Appendix for operation from sea level to above 7500 ft (2300m).

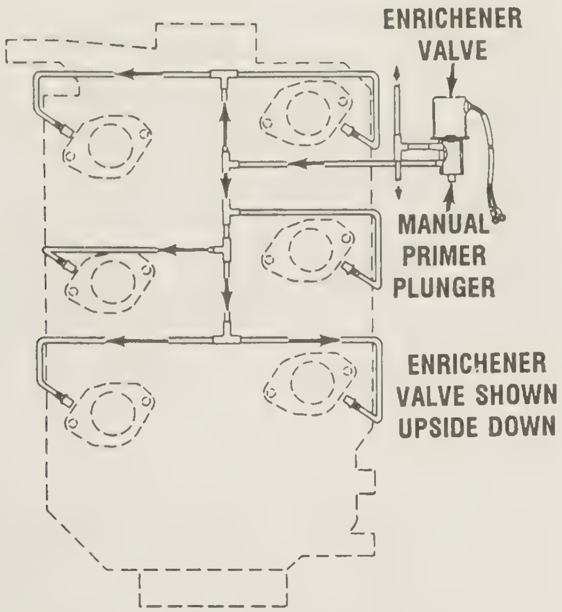
Enrichener System

The enrichener system accomplishes the same function as the old hand choke method by providing an initial rich fuel charge for starting a cold powerhead.

The system consists of an electric solenoid valve mounted on the port or starboard side of the powerhead -- depending on the powerhead model. The valve is gravity fed with fuel from the float bowl of the top carburetor. When the ignition key, or choke button is pushed in and held, electrical current is supplied to the valve. The valve opens and allows fuel to pass thru. The enrichener fuel is then routed through hoses to the base of the lower two carburetors on Models 135 thru 225hp and to all six carbu-



Line drawing to depict a typical enrichener circuit for the Model 135 thru 225hp with three carburetors.



Another line drawing to depict the enrichener circuit for the Model 275hp with six carburetors. Note: The drawing shows the enrichener valve upside down.

retors on Model 275hp. The fuel is then sprayed into the venturi of the carburetor.

When the key or choke knob is released, the valve will close and cut off the enrichener system.

In the event the enrichener system is still in use -- open -- after the powerhead has warmed to operating temperature, the powerhead would flood with fuel, sputter, and finally "die".

If the enrichener valve should fail to operate, the system may be operated manually. Squeeze the primer bulb at the fuel system connect hose until it feels firm. Open the powerhead cowling and depress the manual plunger **IN** on the enrichener valve. Hold the manual plunger for approximately five seconds, then release it. Now, start the powerhead, allow it to warm to operating temperature before shutting down and installing the cowling.

Thermal Air Valve Circuit

The thermal air valve circuit function replaces the choke system used on early model powerheads with carburetors. Essentially, it enables the carburetor to provide a rich fuel mixture to the powerhead after cold start-up and until the powerhead reaches a predetermined temperature.

The system consists of a temperature sensing valve located below the #3 spark plug and hose assembly connecting the idle circuits of the carburetors together. When powerhead temperature is below 100° F (38°C), the thermal valve is closed. When the powerhead is cold and running, the closed thermal air valve restricts air flow within the idle circuit of each carburetor, causing the idle circuit fuel mixture to be on the rich side. As the powerhead warms past 100° F, the temperature sensing valve opens. The open valve no longer restricts air flow to the idle circuit, and air/fuel mixture is returned to normal for efficient powerhead operation.

4-3 TROUBLESHOOTING

The following paragraphs provide an orderly sequence of tests to pinpoint problems in the system. It is very rare for the carburetor by itself to cause failure of the powerhead to start.

FUEL PROBLEMS

Many times the fuel system troubles are caused by a plugged fuel filter, a defective fuel pump, or by a leak in the line from the fuel tank to the fuel pump. A defective fuel enrichener system may cause problems. **WOULD YOU BELIEVE**, a majority of starting troubles which are traced to the fuel system are the result of an empty tank or aged -- "sour" -- fuel.

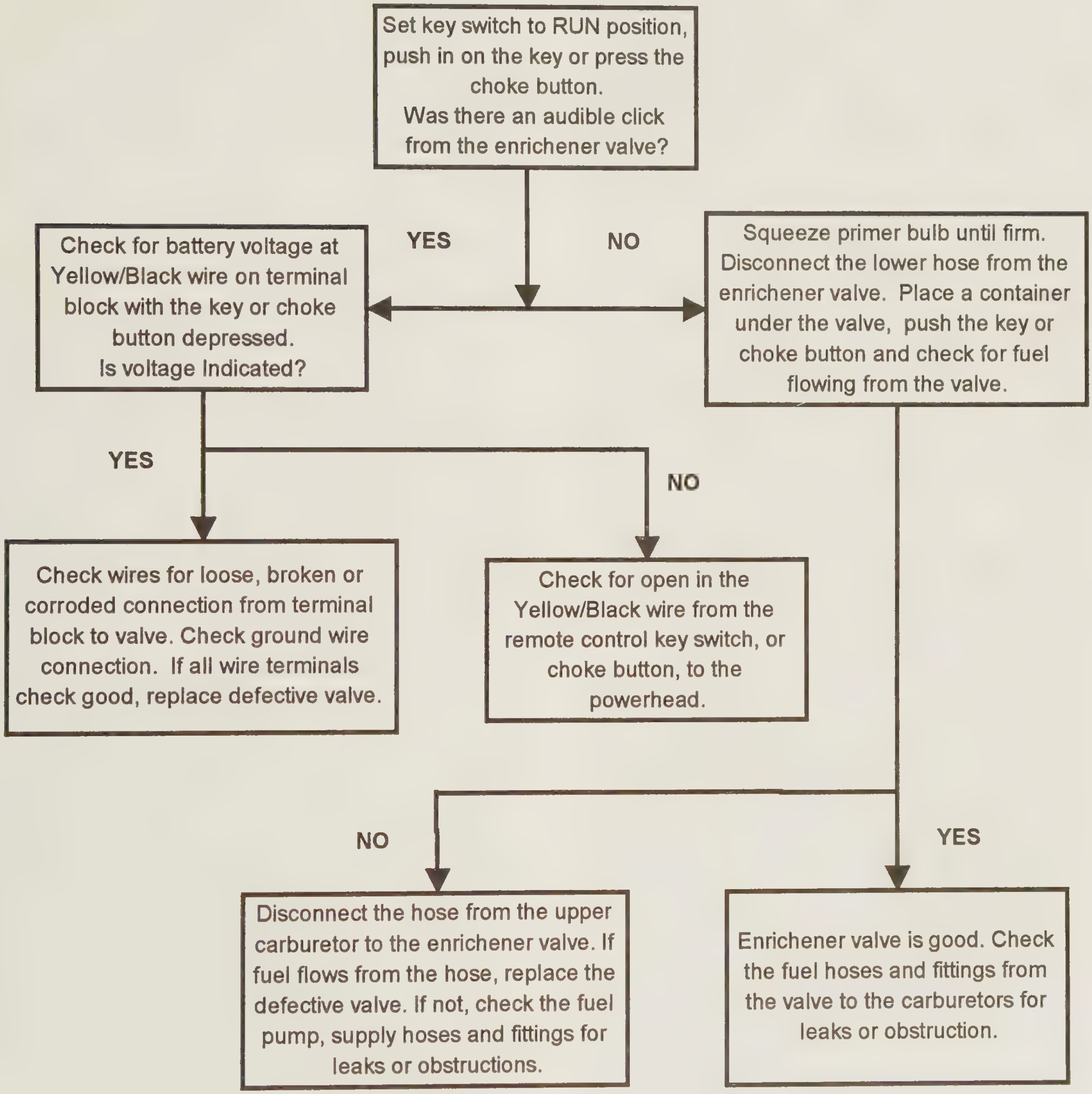
"SOUR" FUEL

Under average conditions (temperate climates), fuel will begin to breakdown in about four months. A gummy substance forms in the bottom of the fuel tank and in other areas. The filter screen between the tank and the carburetor and small passages in the carburetor will become clogged. The gasoline will begin to give off an odor similar to rotten eggs. Such a condition can cause the owner much frustration, time in cleaning components, and the expense of replacement or overhaul parts for the carburetor.

Even with the high price of fuel, removing gasoline that has been standing unused over a long period of time is still the easiest and least expensive preventative maintenance possible. In most cases, this old gas can be used without harmful effects in an automobile using regular gasoline.

The gasoline preservative additive Quicksilver Gasoline Stabilizer and Condi-

ENRICHENER VALVE TEST



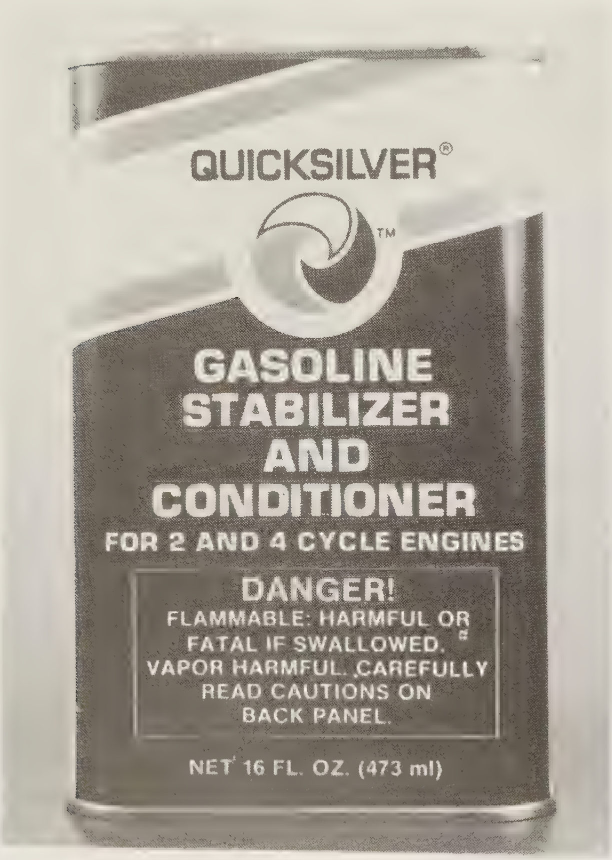
tioner, shown below, will keep the fuel "fresh" for up to twelve months. If this particular product is not available in your area, other similar additives are produced under various trade names.

LEADED GASOLINE AND GASOHOL

In 1988, the United States Environmental Protection Agency (EPA) enacted a mandatory phase-out of leaded fuel "Regular" gasoline. In many areas it is now almost impossible to obtain leaded fuel. Lead in gasoline boosts the octane rating (energy). Therefore, if the lead is removed, it must be replaced with another agent. Unknown to the general public, many refineries are adding alcohol in an effort to hold the octane rating.

Alcohol in gasoline can have a deteriorating effect on certain fuel system parts. Seals can swell, pump check valves can swell, diaphragms distort, and other rubber or neoprene composition parts in the fuel system can be affected.

Since 1980, the manufacturer has made every effort to use materials capable of resisting the alcohol being added to fuels.



Quicksilver Gasoline Stabilizer and Conditioner may be used to prevent the fuel from "souring" for up to twelve full months.

Fuels containing alcohol will slowly absorb moisture from the air. Once the moisture content in the fuel exceeds about 1/2 of 1% , it will separate from the fuel taking the alcohol with it. This water/alcohol mixture will settle to the bottom of the fuel tank. The engine will fail to operate.

Therefore, storage of this type of gasoline for use in marine engines is not recommended for more than just a few days. All marine engines produced since the late 80's are now designed to run on the lower octane fuels available today. In most cases, adding racing fuel or octane additives will only provide a marginal increase in performance.

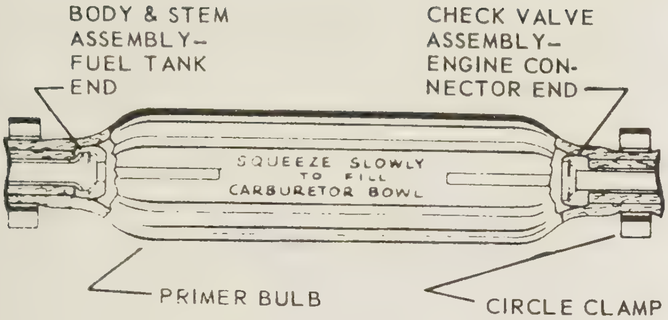
REMOVING FUEL FROM THE SYSTEM

For many years there has been the widespread belief that simply shutting off the fuel at the tank and then running the engine until it stops is the proper procedure before storing the engine for any length of time. Right? **WRONG!**

It is **NOT** possible to remove all of the fuel in each carburetor by operating the engine until it stops. Some fuel is trapped in the float chamber and other passages and in the line leading to the carburetors. The **ONLY** guaranteed method of removing **ALL** fuel is to take the time to remove the carburetors and drain the fuel.

If the engine is operated with the fuel supply shut off until it stops, the fuel and oil mixture inside the engine is removed, leav-

Damaged piston, possibly caused by insufficient oil mixed with the fuel; using too-low an octane fuel; or using fuel that has "soured" (stood too long without a preservative added).

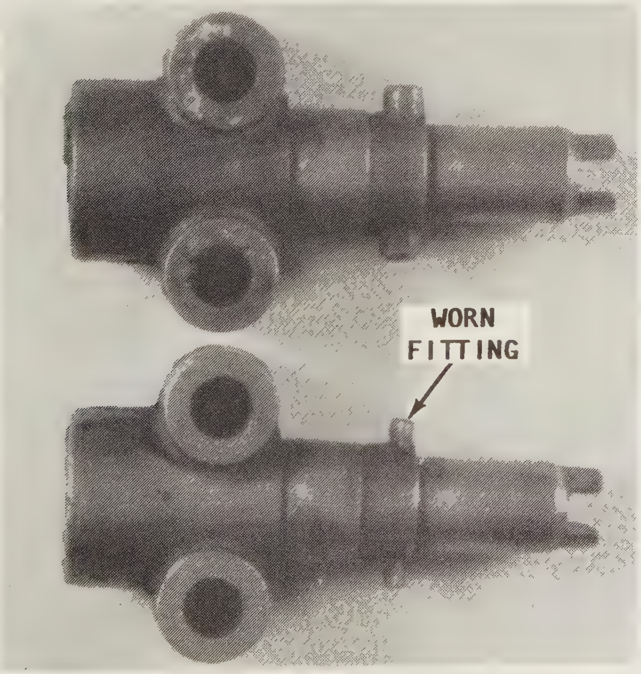


Major parts of a common fuel line squeeze bulb.

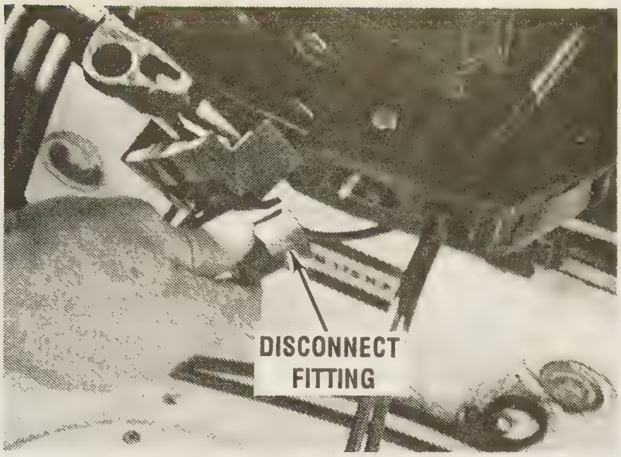
ing bearings, pistons, rings, and other parts with little protective lubricant, during long periods of storage.

Proper procedure involves: shutting off the fuel supply at the tank; disconnecting the fuel line at the tank; operating the engine until it begins to run **ROUGH;** then stopping the engine, which will leave some fuel/oil mixture inside; and finally removing and draining each carburetor. By disconnecting the fuel supply, all **SMALL** passages are cleared of fuel even though some fuel is left in the carburetors. A light oil should be inserted into the combustion chamber. On some model carburetors, the high-speed jet plug can be removed to drain fuel.

For short periods of storage, simply running the carburetors dry may help prevent severe gum and varnish from forming in the



Comparison of a new (top) and worn (bottom) male fuel connector. The pins on the bottom connector are worn — smaller and tapered, therefore, the connector will fail to maintain adequate fuel flow.



Female portion of the quick disconnect fitting ready to be mated with the male portion on the powerhead.

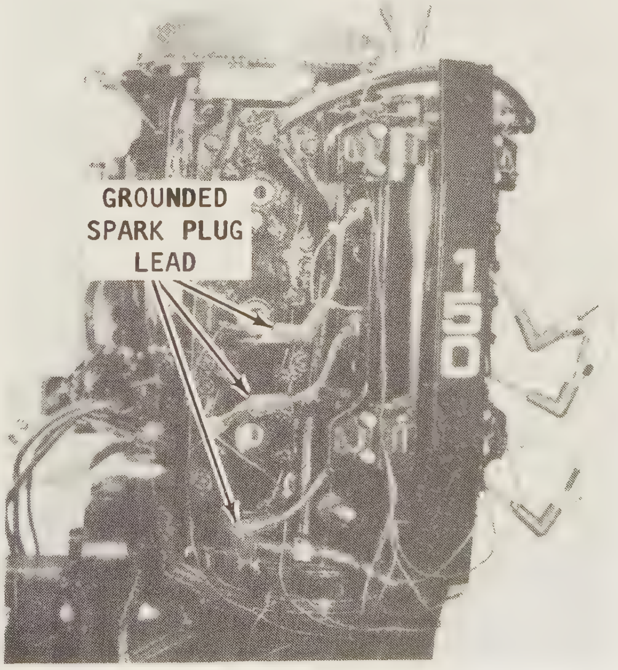
carburetor. This is especially true during hot weather.

FUEL PUMP TEST

CAUTION

Gasoline will be flowing in the powerhead area during this test. Therefore, guard against fire by grounding the high-tension leads to prevent them from sparking.

The high-tension leads between the coils and the spark plugs can be grounded by connecting



Grounding the spark plug leads to the powerhead in preparation to making fuel flow tests. The grounding is ***NECESSARY*** *to prevent a spark from igniting fuel vapors or fuel being handled in the open.*

a jumper wire from the primary side of the ignition coil to a good ground. An alternate safety method, and perhaps a better one, is to ground each spark plug lead. Disconnect the fuel line at the top carburetor. Place a suitable container under the open fuel line to catch the fuel discharged. Now, squeeze the primer bulb and observe if there is satisfactory fuel flowing from the line.

If there is no fuel discharged from the line, the check valve in the squeeze bulb may be defective, or there may be a break or obstruction in the fuel line.

If there is a good fuel flow, then crank the engine. If the fuel pump is operating properly, a healthy stream of fuel should pulse out of the line.

Continue cranking the engine and catching the fuel for about 15 pulses to determine if the amount of fuel decreases with each pulse or maintains a constant amount. A decrease in the discharge indicates a restriction in the line. If the fuel line is plugged, the fuel stream may stop. If there is fuel in the fuel tank but no fuel flows out of the fuel line while the powerhead is being cranked, the problem may be in one of four areas:

1- The line from the fuel pump to the carburetor may be plugged as already mentioned.

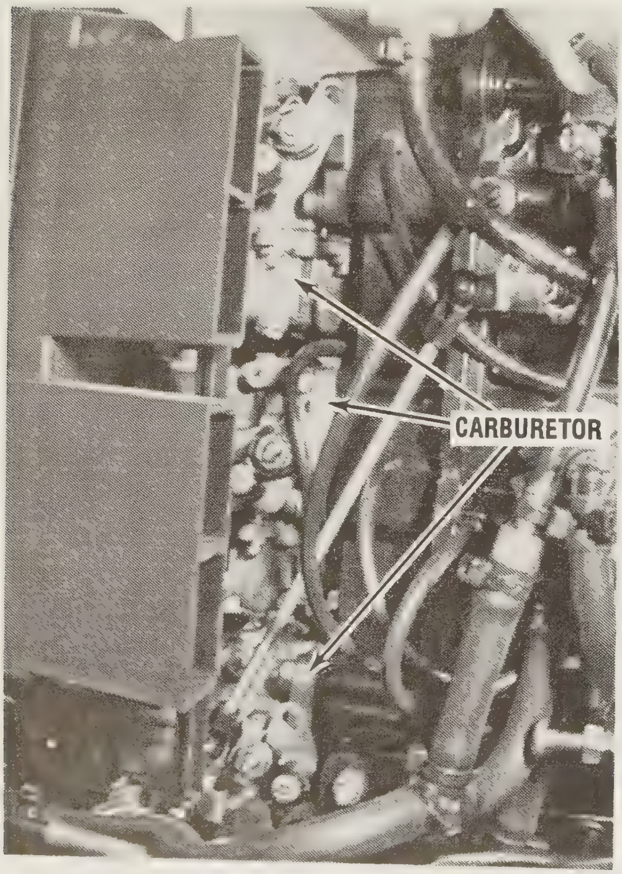
2- The fuel pump may be defective.

3- The line from the fuel tank to the fuel pump may be plugged; the line may be leaking air; or the squeeze bulb may be defective.

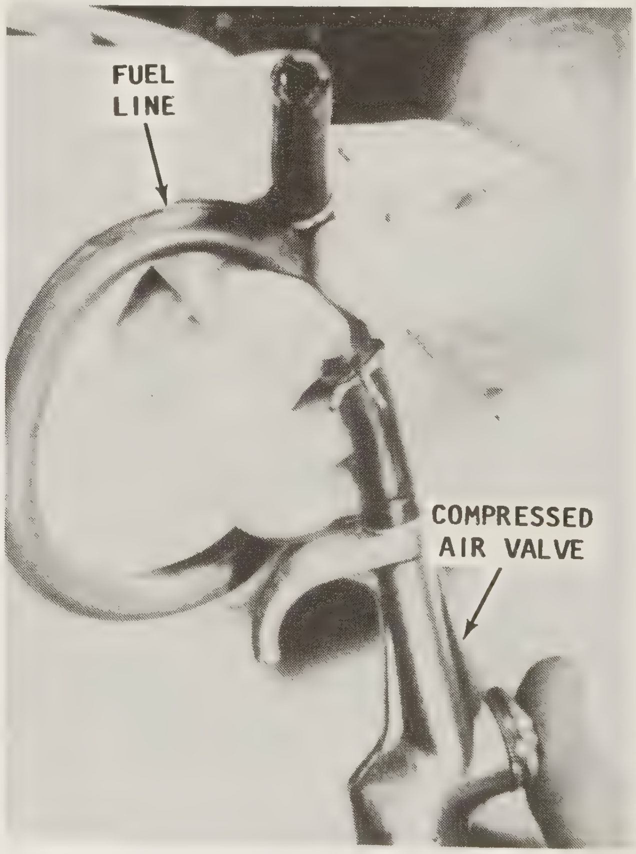
4- If the powerhead fails to start, even with adequate fuel flowing from the fuel line, the fuel inlet needle valve and seat may be gummed together and prevent adequate fuel flow into the carburetor. Check, and correct the condition, if necessary.

FUEL LINE TEST

Possible cause of fuel line problems may be deterioration of the inside lining of the fuel line which may cause some of the lining to develop a blockage similar to the action of a check valve. Therefore, if the fuel line



*If tests indicate a satisfactory fuel flow to the carburetors, but adequate fuel quantity is not reaching the cylinders, then the carburetors **MUST** be removed and serviced.*



*Many times, restrictions such as foreign material may be cleared from the fuel line using compressed air. Use **CARE** to be sure the open end of the hose is pointing clear to avoid personal injury to the eyes.*

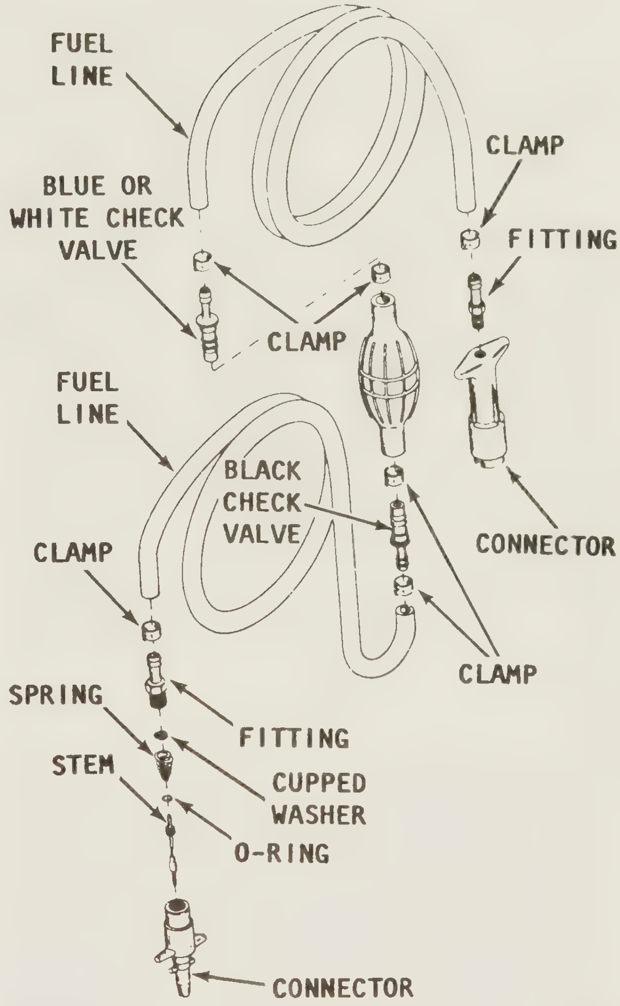
appears the least bit questionable, replace the entire line.

Another possible restriction in the fuel line may be caused by some heavy object lying on the line -- a tackle box, etc.

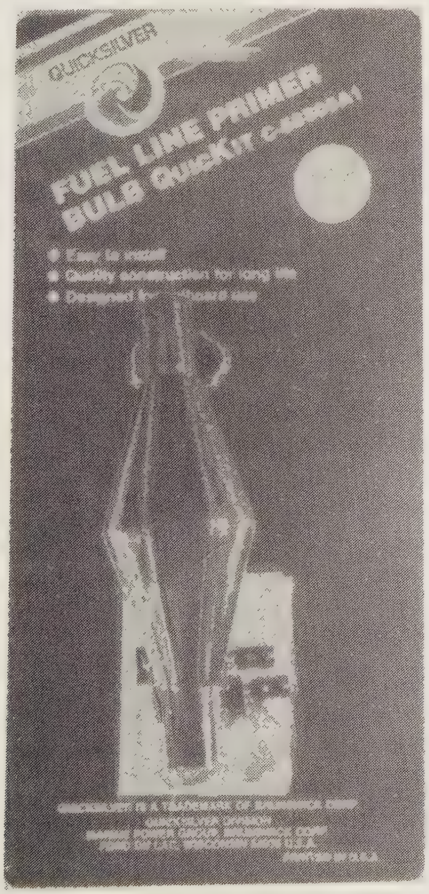
The fuel line from the tank to the fuel pump can be quickly tested by disconnecting the existing fuel line at the fuel pump and connecting a spare portable tank and fuel line. This simple substitution eliminates the fuel tank and fuel lines in the boat. Now, start the engine and check the performance.

If the problem has been corrected, the fuel system between the fuel pump inlet and the fuel tank is at fault. This area includes the fuel line, the fuel pickup in the tank, the fuel filter, anti-siphon valve, the fuel tank vent, and excessive foreign matter in the fuel tank, and loose fuel fittings sucking air into the system. Improper size fuel fittings can also restrict fuel flow.

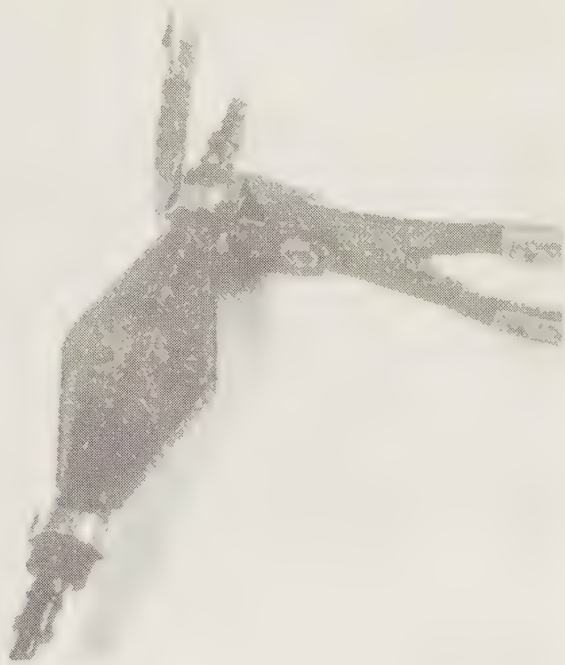
On most installations, the fuel line is provided with quick-disconnect fittings at the tank and at the engine. If there is reason to believe the problem is at the



Exploded drawing of a typical fuel line and primer bulb with major parts identified.



A replacement squeeze bulb kit includes parts necessary to return this section of the fuel line to service.



Using the proper tools to install a clamp around the squeeze bulb check valve.

quick-disconnects, the hose ends should be replaced as an assembly. For a small additional expense, the entire fuel line can be replaced, thus eliminating this area as a problem source for many future seasons.

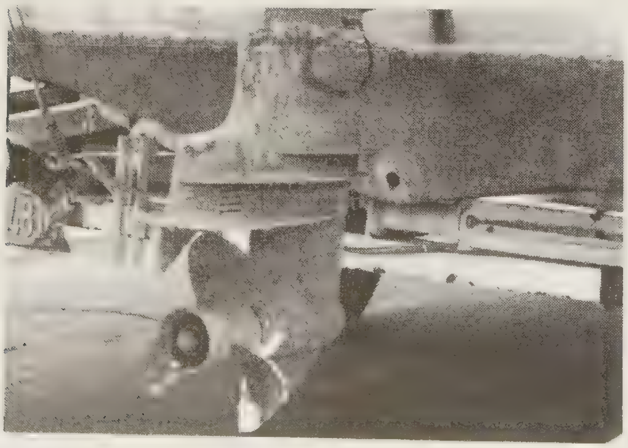
The primer squeeze bulb can be replaced in a short time. First, cut the hose line as close to the old bulb as possible. Slide a small clamp over each end of the fuel line. A check valve is installed on each end of the primer bulb. The White check valve is installed on the end of the primer bulb pointing towards the fuel tank. The Black or Blue check valve is installed on the end of the primer bulb pointing towards the powerhead fuel connector. Use a small amount of Primer Bulb Adhesive on all hose and check valve connections to ensure a good tight seal. Slide the clamps over the hose connections and tighten them snug.

ROUGH POWERHEAD IDLE

If the powerhead does not idle smoothly, the most reasonable approach to the problem is to perform a tune-up to eliminate such areas as a faulty spark plug or plugs or the timing being out of adjustment.

Other problems preventing a powerhead from operating smoothly include: An air leak in the intake manifold; uneven compression between cylinders; and sticky or broken reeds.

Of course any problem in the carburetor affecting the air/fuel mixture will also prevent the powerhead from operating smoothly at idle speed. These problems usually include, but are limited to: Fuel level in the bowl too high; a "heavy" float; leaking needle valve and seat; defective enrichener valve; and improper adjustments for idle mixture or idle speed.



A boat and lower unit covered with marine growth, usually the result of leaving the boat in the water for long periods of time. The time for such growth to develop is drastically shortened in salt water and in warm temperatures. Such a condition seriously hinders proper performance.

EXCESSIVE FUEL CONSUMPTION

Excessive fuel consumption can be the result of any one of three conditions, or a combination of all three.

1- Inefficient engine operation.

2- Faulty condition of the hull, including excessive marine growth.

3- Poor boating habits of the operator.

If the fuel consumption suddenly increases over what could be considered normal, then the cause can probably be attributed to the engine or boat and not the operator.

Marine growth on the hull can have a very marked effect on boat performance. This is why sail boats always try to have a haul-out as close to race time as possible. While you are checking the bottom take note of the propeller condition. A bent blade or other damage will definitely cause poor boat performance.

If the hull and propeller are in good shape, then check the fuel system for possible leaks. Check the line between the fuel pump and the carburetor while the engine is running and the line between the fuel tank and the pump when the engine is not running. A leak between the tank and the pump many times will not appear when the engine is operating, because the suction created by the pump drawing fuel will not allow the fuel to leak. Once the engine is turned off and the suction no longer exists, fuel may begin to leak.

If a minor tune-up has been performed and the spark plugs, points, and timing are properly adjusted, then the problem most likely is in the carburetor and an overhaul is in order. Check the needle valve and seat for leaking. In an effort to conserve fuel, use extra care when making any adjustments affecting the fuel consumption, such as the float level or automatic choke.

ENGINE SURGE

If the engine operates as if the load on the boat is being constantly increased and decreased, even though an attempt is being made to hold a constant engine speed, the problem can most likely be attributed to the fuel pump, or a restriction in the fuel line between the tank and the carburetor.

Operational description and service procedures for the fuel pump are given in Section 4-8.

4-4 ANTI-SYPHON VALVE

WORDS ON REQUIREMENT

At press time, in the United States, there is no governmental regulation requiring on outboard unit to be equipped with an anti-syphon valve. However, boats complying with the NMMA (National Marine Manufacturers Association) certification program equipped with permanently installed fuel tanks are required to have an anti-syphon valve. Bear in Mind, the NMMA sets a standard which is not subject to enforcement by any governmental agency.

An anti-syphon valve is considered an "After Market" item, not installed by the factory. Many people consider such a device to be a safety item, but more often than not, the valve may cause more problems in the fuel delivery system than it solves.

If the valve becomes the least bit clogged with debris or a too small valve is installed in the fuel line, or the spring is too stout, a pressure drop may develop from one side of the valve to the other. A pressure drop across the anti-syphon valve can cause poor powerhead performance and possible damage.

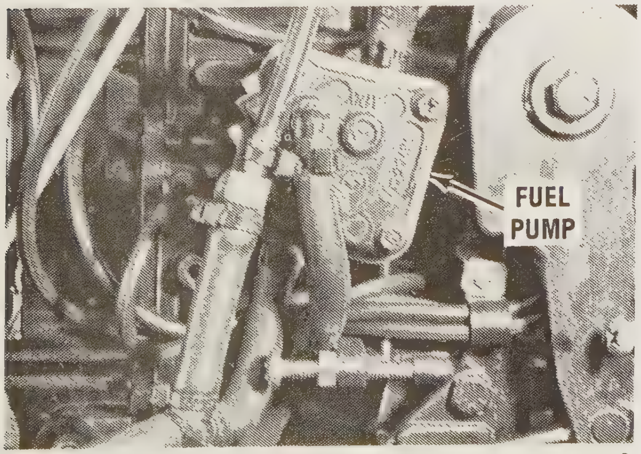
A defective or poorly operating anti-syphon valve may cause one or more of the following problems.

Inadequate fuel pump pressure.

Loss of power at the powerhead.

Powerhead surge at high speed rpm.

Piston dome erosion due to pre-ignition or detonation.



Typical fuel pump installation on the V6 powerheads covered in this manual. Oil from, the oil pump, enters the system through a clear plastic line and "T" fitting just before fuel enters the pump.

Poor powerhead performance during acceleration -- unit falters or cuts out completely.

Powerhead fails to operate smoothly -- runs "rough".

Powerhead cannot be started.

Checking Anti-syphon Valve

If troubleshooting should indicate the anti-syphon valve is at fault, attempt to operate the powerhead with a separate fuel source. In other words, the valve is physically bypassed.

If the valve proves to be the source of the problem, either remove the valve from the fuel line or replace the valve with a solenoid operated fuel shutoff valve.

Such a valve may be purchased, or at least ordered, from any Mercury/Mariner dealer for a modest cost. If the valve is purchased, it can be installed without special tools according to the instructions in the package.

CARBURETOR IDENTIFICATION

This information was presented at the beginning of this chapter and is repeated here to **ENSURE** the reader understands which Walbro carburetor is installed on the powerhead being serviced and he will follow the proper procedures.

At press time all carburetors installed on the powerheads covered in this manual were three different versions of the Walbro. For ease of identification and reference the carburetors have been assigned letter designations, **"A"**, **"B"**, and **"C"**.

Carburetor **"A"** -- Walbro WH -- with two barrels and two floats is installed on Model 135hp thru 200hp -- 1990 **ONLY.** See Section 4-5 beginning on the next page.

Carburetor **"B"** -- Walbro WMH -- two barrels and only one float, has been installed on Model 135hp thru 225hp since 1991. The 1991 carburetor had an accelerator pump. After 1991, the pump circuit was no longer used and the opening for the pump was merely sealed with a plug. Procedures are presented in Section 4-6, beginning on Page 4-22

Carburetor **"C"** -- Walbro WO -- with a single barrel and a dual float in a single bowl has been installed on the Model 275hp powerhead since 1990. Six carburetors serve the powerhead -- one for each cylinder. See Service procedures in Section 4-7, beginning on Page 4-32.

4-5 CARBURETOR "A" WALBRO WM TWO BARREL -- DUAL FLOAT MODELS 135HP THRU 200HP 1990 ONLY

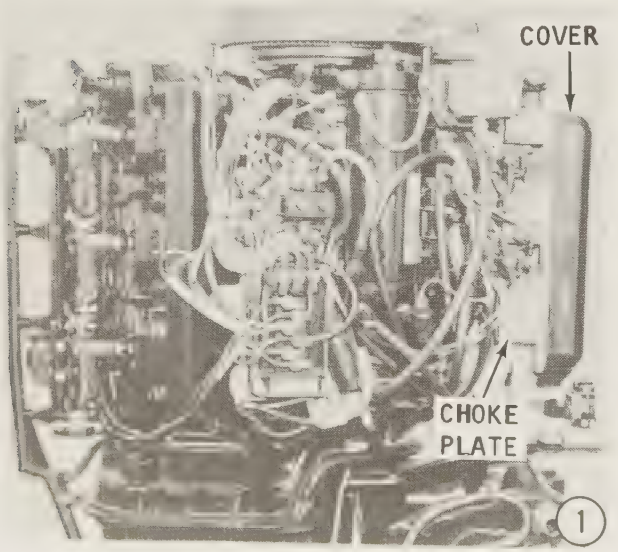
This section provides complete detailed illustrated service procedures to remove, disassemble, clean and inspect, assemble, make bench adjustments, install, and then make operating adjustment for the carburetor listed in the heading on the indicated V6 60° powerheads. Complete instructions to synchronize the fuel with the ignition system are given in Chapter 6.

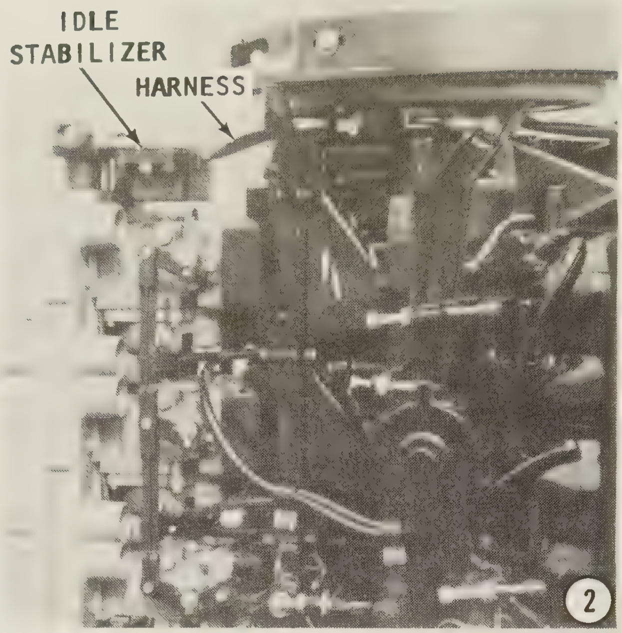
As the name implies, this carburetor has a double throat, double bowl, and double float system incorporated into a single body. By using three of these carburetors on a V6 powerhead, each cylinder is serviced by an individual carburetor throat, and associated mechanism. Each throat and mechanism functions independently from the other. **REMEMBER**, this fact when troubleshooting the fuel system. The ignition system also has a separate unit for each cylinder.

Because the carburetors are identical, all of the procedures in this section may be repeated for each carburetor.

REMOVAL AND DISASSEMBLING

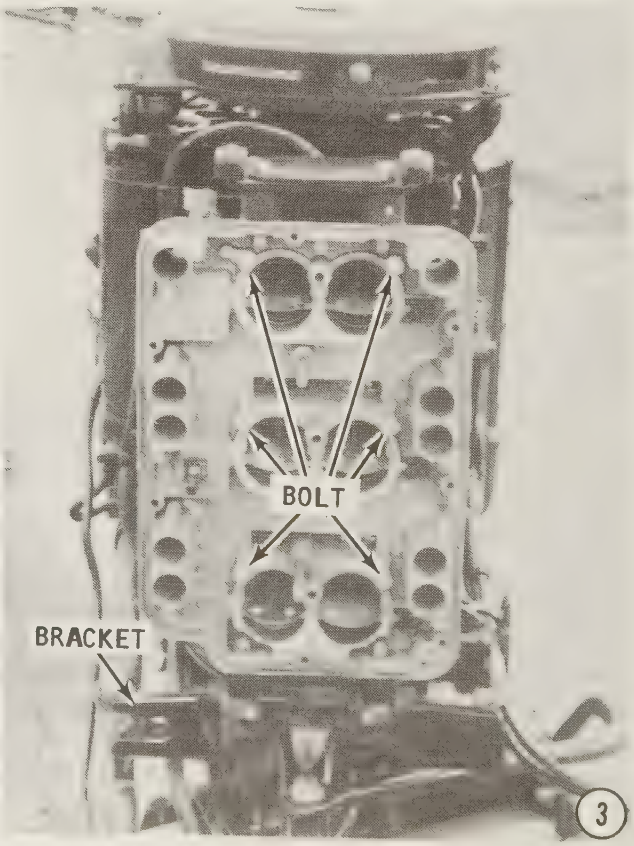
1- Disconnect the battery leads from the battery terminals. Disconnect the fuel line at the fuel tank or at the powerhead. Remove the two bolts on the front of the cover and lift the cover from the attenuator. On the rear of the attenuator plate, disconnect the bleed hose from the fitting on the port side lower corner.

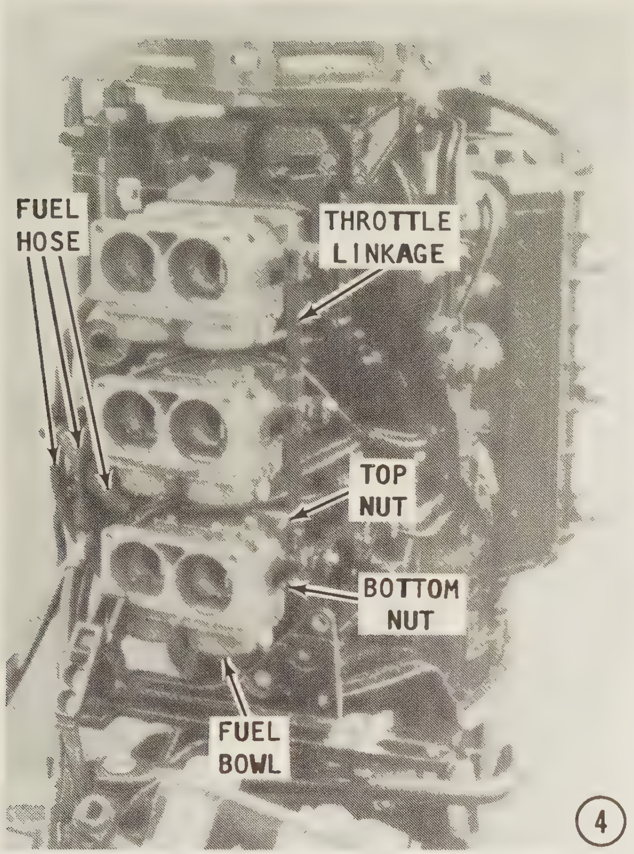




2- Trace the electrical harness from the idle stabilizer, mounted on top of the attenuator plate, to the powerhead switch box. This harness will contain three multicolored wires; a White/Black, a Red/White, and a Black wire. Make a note -- to which terminal-- at the switch box -- these wires are connected, then disconnect all three.

3- Remove the six bolts securing the attenuator plate to the carburetors, and then lift



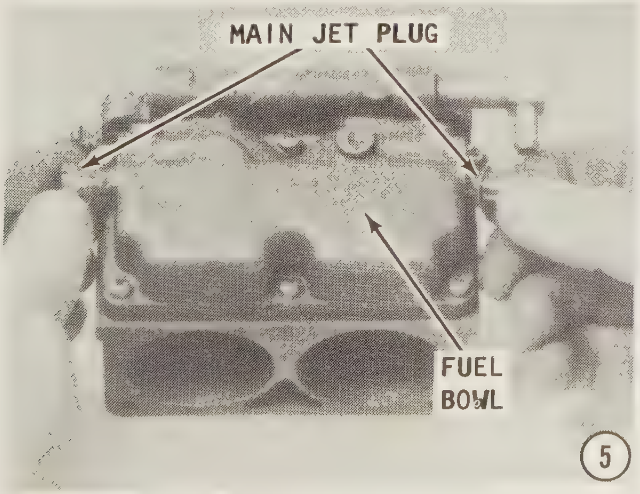


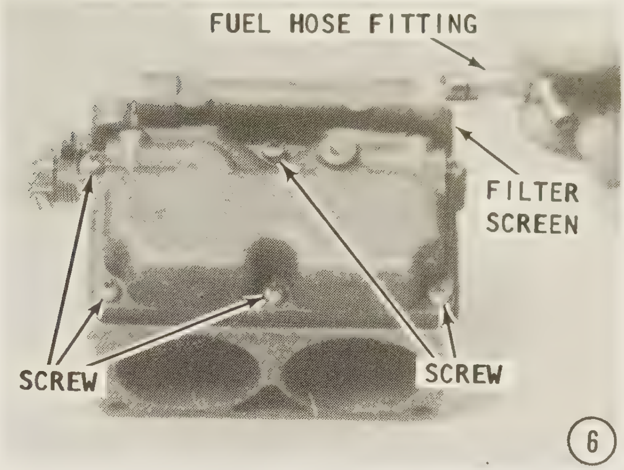
the plate free of the carburetors. Disconnect the fuel inlet hose to the top carburetor, middle carburetor and the bottom carburetor. Disconnect the fuel enrichener hose from each fitting on the starboard side of the carburetors.

4- Disconnect the throttle linkage by removing the three screws, one at each carburetor and the oil pump control link arm. Slide the throttle linkages off the throttle shaft. Disconnect the bleed hoses from each carburetor.

GOOD WORDS

Each carburetor **MUST** be installed back into the exact location from which it was





removed. The jets on the port and starboard side may differ on an individual carburetor **AND** the jets differ from one carburetor to another, top, center, and bottom. Therefore, **TAKE TIME** to make an identification mark on each carburetor before removing it from the powerhead. **DO NOT** make a mark on the mating surface to the choke plate. A preferred location is on the float bowl.

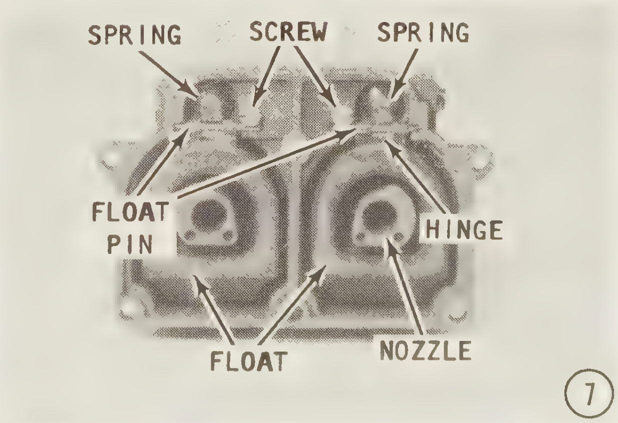
Remove the four attaching nuts securing each carburetor to the intake manifold, and then remove the carburetor.

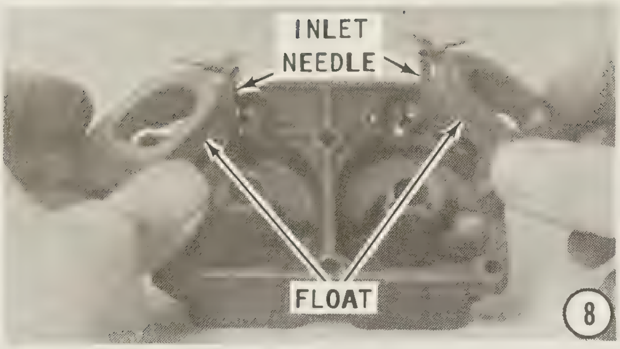
Float Bowl

5- Remove the two main jet plugs and gaskets, one on each side in the bottom of the carburetor bowl. After the plugs have been removed, note the size of each high speed jet inside each plug. The jets may now be removed from the plugs using the proper size screwdriver and wrench.

Main jet sizes must be changed when operating the powerhead at elevations higher than 2,500 feet above sea level. Consult the table in the Appendix for the correct main jet sizes for various elevations.

6- Remove the fuel inlet hose fitting.





Check the filter screen inside the hole. Remove the screen. The factory does not recommend using a filter in the carburetor.

Turn the carburetor upside down and remove the six screws securing the bowl to the carburetor body. Lift the bowl from the body, and then remove and discard the bowl gasket and the two nozzle gaskets.

7- Remove the two screws holding the float pins to the fuel bowl.

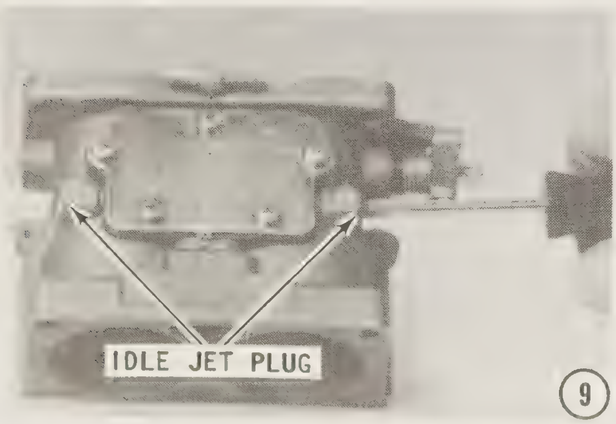
8- Lift out both floats, pins, and inlet needles. Remove both inlet needle seats and the gasket under each seat from the fuel bowl.

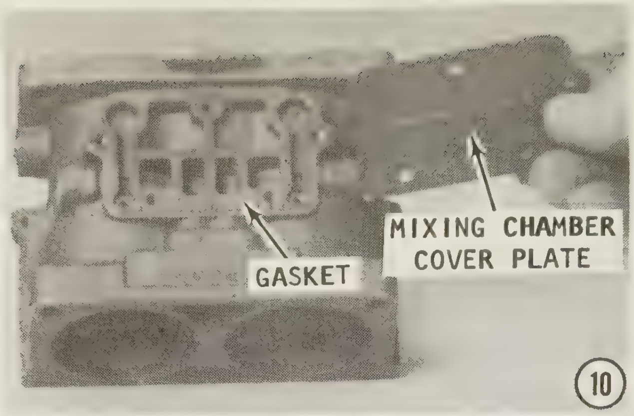
Body Disassembling

9- Remove the two idle jet plugs and gaskets. A plug is located on each side of the body near the top edge. Using the **PROPER** size screwdriver, remove the jets from the plugs. **TAKE TIME** to set the jets and other small parts aside, and in order, to ensure they will be installed back in the proper sequence and location.

SPECIAL WORDS

The two idle jets are not normally disturbed during a carburetor overhaul. However, the idle jets together with the main jets and the fuel bowl vent jets, must be changed when operating the powerhead at elevations higher than 2,500 feet above sea





level. Consult the table in the Appendix for the correct main jet and vent sizes for various elevations.

10- Remove the five screws securing the cover plate to the mixing chamber. Lift off the cover plate and the gasket.

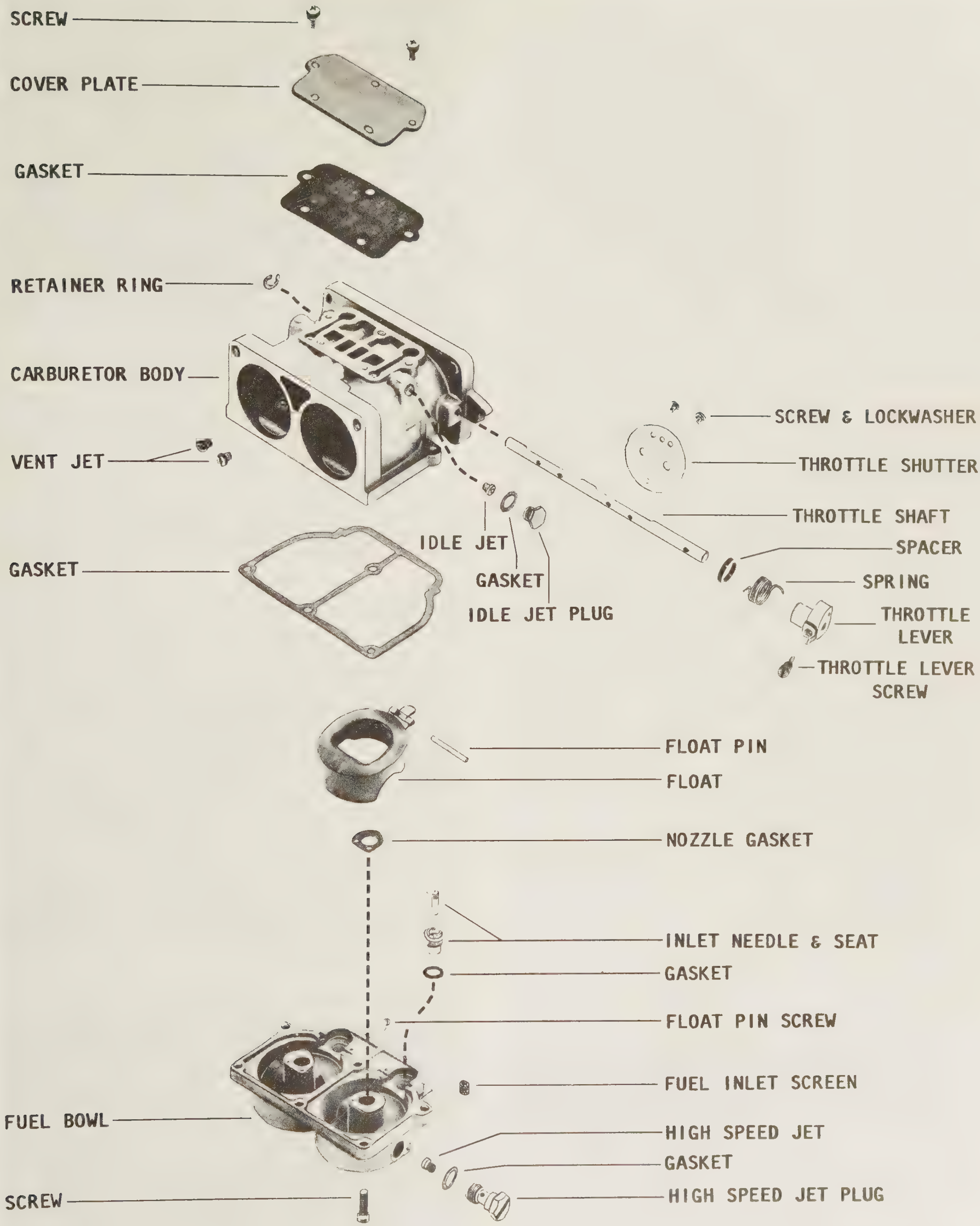
VERY GOOD WORDS

Further disassembly of the carburetor is not necessary in order to clean it properly. Normally it is not necessary to service the fuel bowl vent jets. However, if the jets are removed, they **MUST** be kept in order and installed back into the correct carburetor. **REMEMBER,** the jets sizes differ between top, center, and bottom carburetors. See the table in the Appendix.

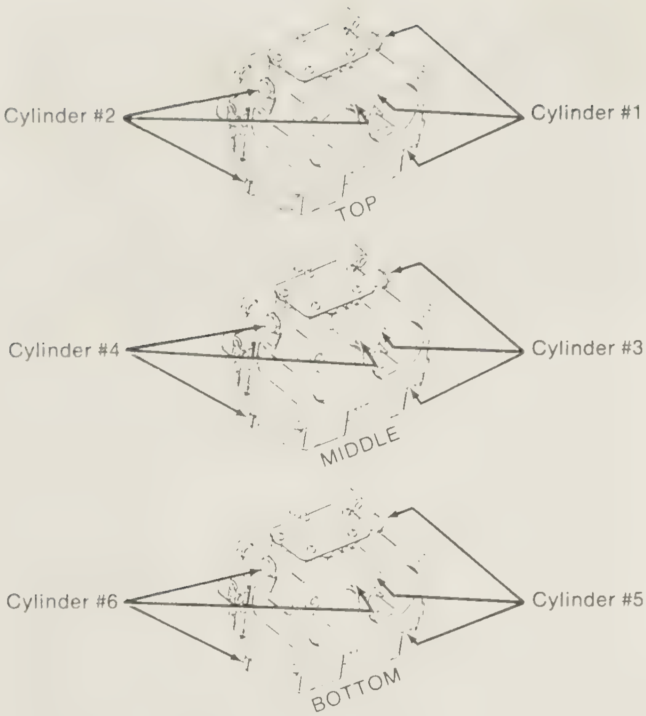
CLEANING AND INSPECTING

NEVER dip rubber, plastic, or nylon parts into liquid automotive type cleaners. Many of these "dip" cleaners are highly toxic, and **DANGEROUS.** Use only a high quality "Choke and Carburetor" spray type cleaner.

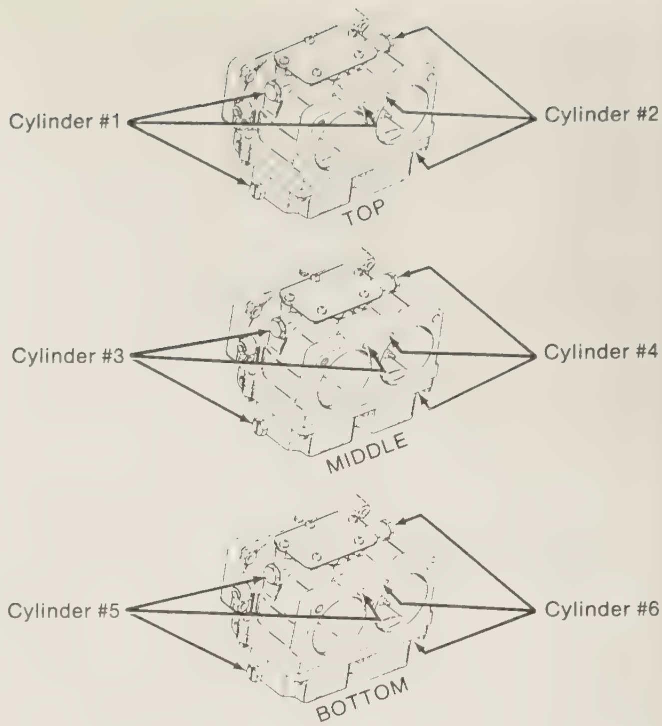
Location of the fuel bowl vent jets. Changing to a jet with smaller orifice will result in a leaner air/fuel mixture at midrange. A larger orifice will result in a richer mixture at midrange.



Exploded drawing of Carburetor "A" -- Walbro WH -- with major parts identified.



*Simple drawing to depict Carburetor "A" or "B" jet delivery to designated cylinders for the Model 135 thru 175hp -- 1990 **ONLY** with vertical reeds installed.*



Simple drawing to depict Carburetor "A" or "B" jet delivery to designated cylinders for the Model 135 thru 225hp -- 1990 and on with horizontal reeds installed.

Spray all metal parts and passages thoroughly with a spray cleaner, and then blow them dry with compressed air. Repeat spraying with cleaner until the unit is **CLEAN.**

Blow out all of the passages in the castings with compressed air. Check all parts and passages to be sure they are not clogged or contain any deposits. **NEVER** use a piece of wire or any type of pointed instrument to clean drilled passages or calibrated holes in a carburetor.

Move the throttle shaft back and forth to check for wear. If the shaft appears to be too loose, replace the complete throttle body because individual replacement parts are **NOT** available.

Examine the throttle shutter plates for damage.

Inspect the main body, airhorn, and venturi cluster gasket surfaces for cracks and burrs which might cause a leak. Check the float for deterioration. Check to be sure the float springs have not been stretched. If any part of the float is damaged, the unit must be replaced. Check the float tab to inlet needle contacting surface and replace the float if a groove has been worn in this surface.

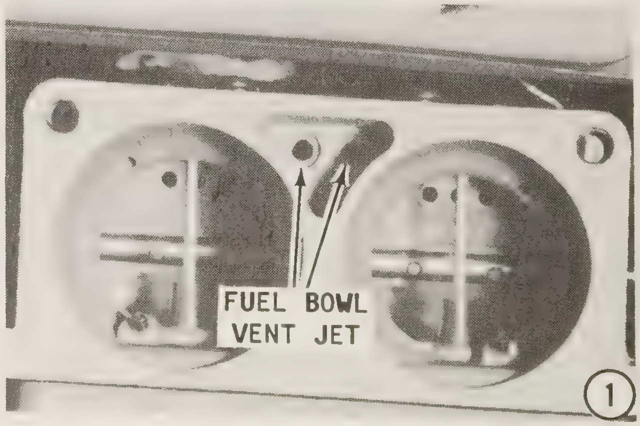
Most of the parts, requiring replacement during a carburetor overhaul, are included in an overhaul kit available from your local marine dealer. This kit will also contain a matched fuel inlet needle and seat. This combination should be replaced each time the carburetor is disassembled as a precaution against leakage.

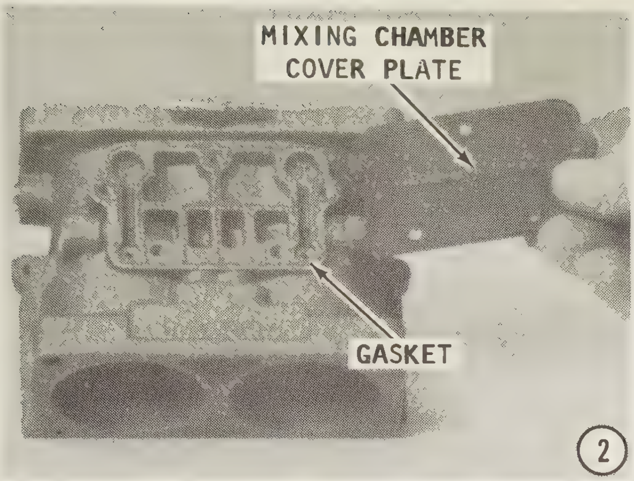
Refer to the Carburetor Jet Size/Elevation Chart in the Appendix for the proper size for your engine, carburetor, and anticipated elevation of operation.

ASSEMBLING AND INSTALLATION

Body Assembling

1- Install the two fuel bowl vent jets between the carburetor throats, if they were removed. Refer to the chart in the Appendix for the correct sizing of these jets.





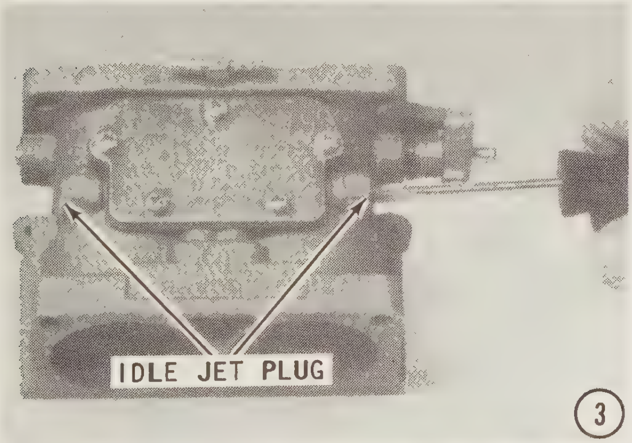
2

2- Place a **NEW** gasket over the mixing chamber. Install the mixing chamber cover and secure it with the attaching hardware.

3- Install the two idle jets into their recesses on either side of the mixing chamber cover. Position a **NEW** gasket on each idle jet plug. Thread the plugs into the **SAME** location from which they were removed, as noted during disassembling.

Fuel Bowl

4- Install both inlet needle seats with **NEW** gaskets into the fuel bowl. Discharge a drop of oil into each seat. Hook the float pin and inlet needle with the spring onto each float. Lower each float into the fuel bowl and at the same time guide the inlet needle into its seat. Secure the float pin to the fuel bowl with the screw tightened securely.



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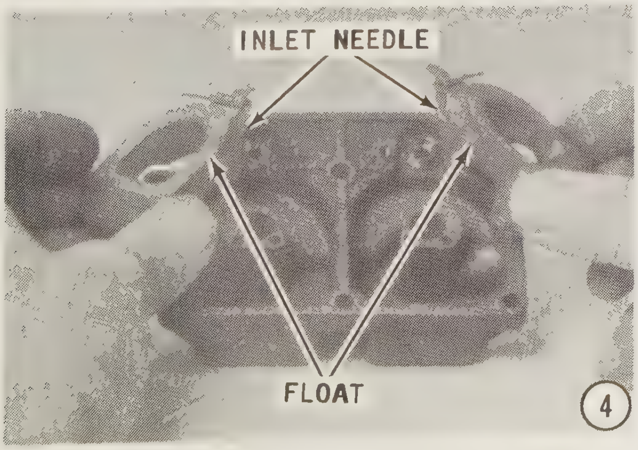

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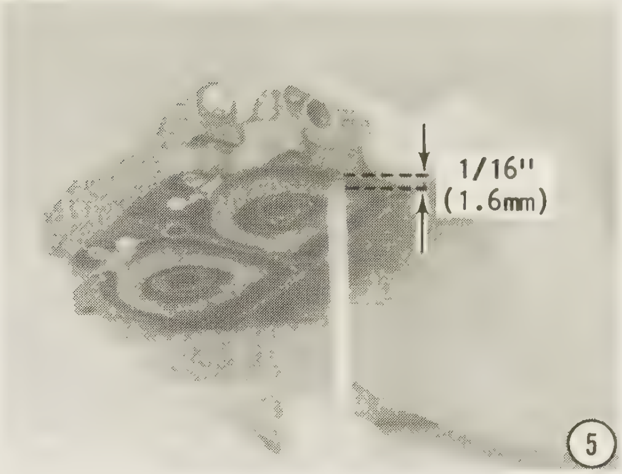

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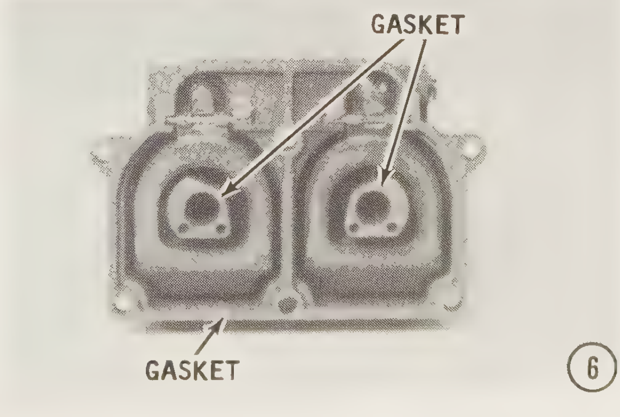
5- Turn the bowl upside down and allow the float to drop. Measure the distance from the base of the bowl to the bottom of the float. This measurement should be 1/16" (1.6mm). **CAREFULLY** bend the float tab to obtain the proper measurement.

6- Position a **NEW** fuel bowl gasket onto the carburetor body. Slide a **NEW** nozzle gasket down over each nozzle and into place on the carburetor body. With the carburetor body upside down, lower the bowl assembly onto the body.

7- Secure it in place with the six screws and lockwasher in the sequence shown in the accompanying illustration. Tighten the No. 1 screw **FIRST** and then tighten the others in a circular pattern working in either direction. Tighten the No. 1 screw a second time. The manufacturer does not recommend replacing the fuel filter. Install the fuel hose fitting.



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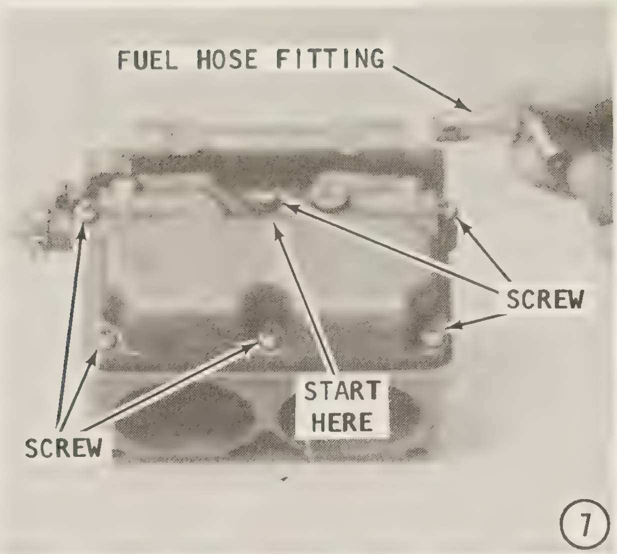

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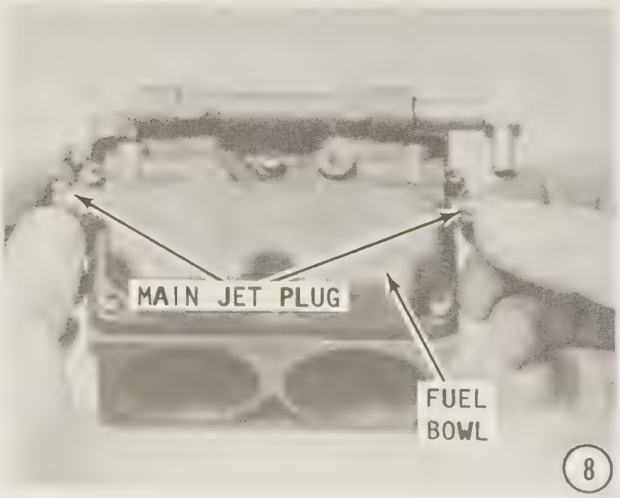
8- Check to be sure each main jet plug has its jet installed. Install the main jet plugs with **NEW** gaskets into both sides of the fuel bowl.

Installation to Powerhead

9- Place a new flange gasket for each carburetor in position on the intake manifold. Install and secure each carburetor in place with the four attaching nuts. Tighten the nuts alternately and evenly to the torque value listed in the Appendix.

Connect all the fuel lines to the carburetors and tighten the clamps securely.

Slide the throttle control linkage over each of the carburetor throttle shafts. Secure each linkage to the shaft with a Phillips head screw. As the connections are made, look into each carburetor to be sure the throttle shutters are **CLOSED**. If the shutters are not closed, loosen the Phillips head screw and force the shutter closed. Tighten the screw and proceed with



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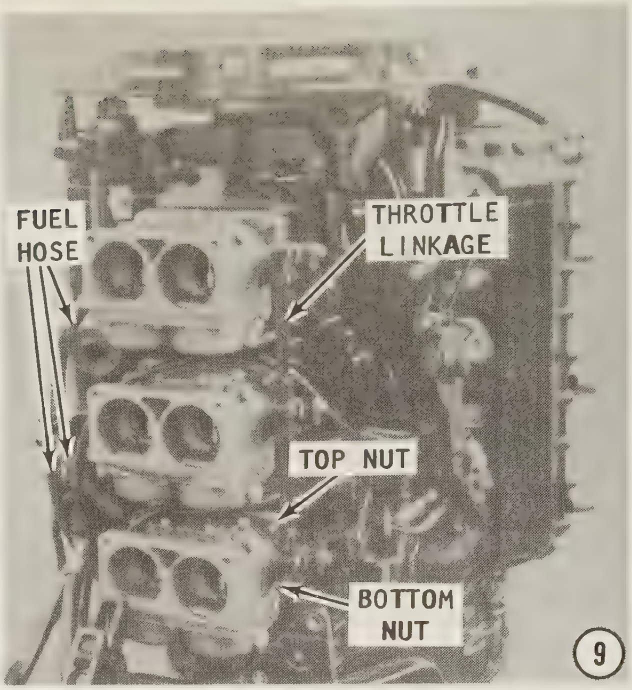
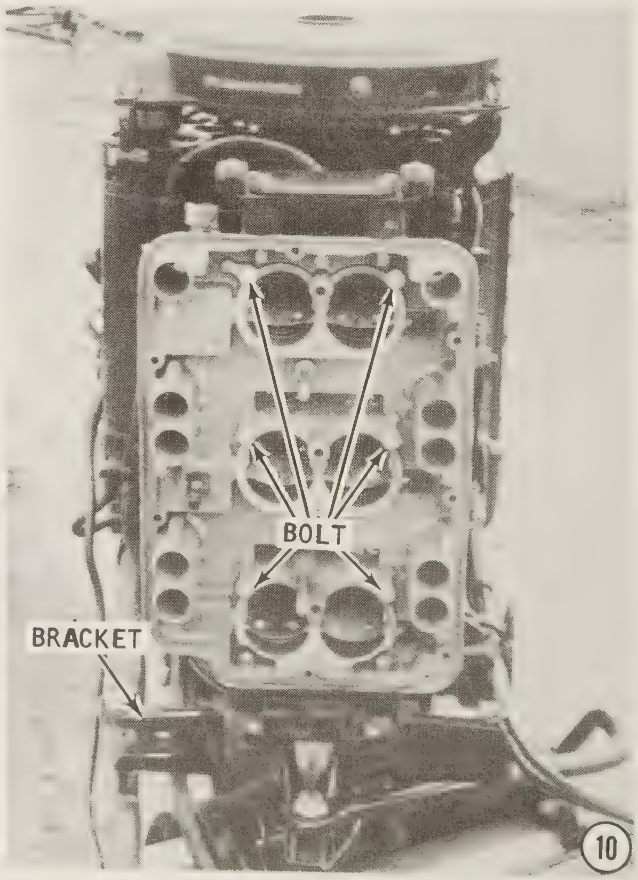


9

connecting the linkage. Connect the oil control lever from the oil pump to the linkage arm.

10- Connect the fuel enrichener hoses to each fitting on the starboard side of the carburetors. Connect the fuel inlet hose to the top carburetor, middle carburetor and the bottom carburetor. Install the attenuator plate over the



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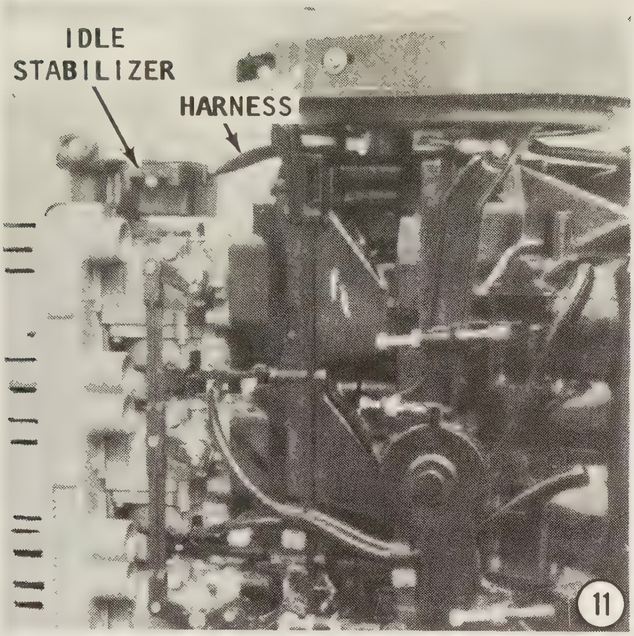
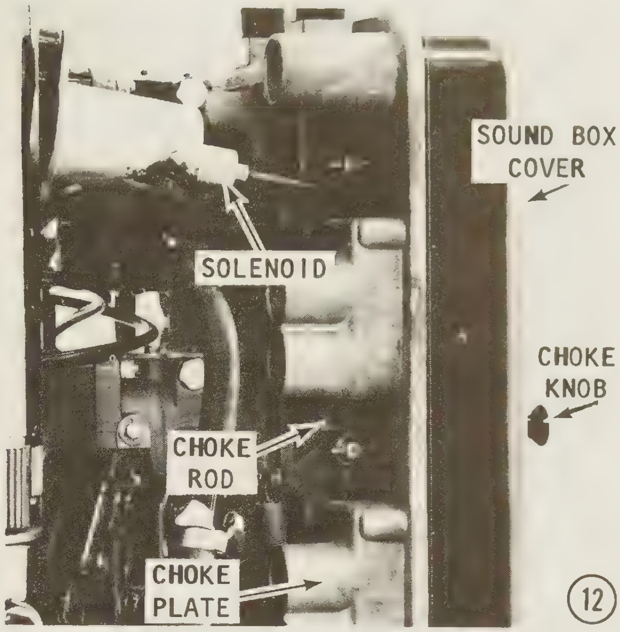
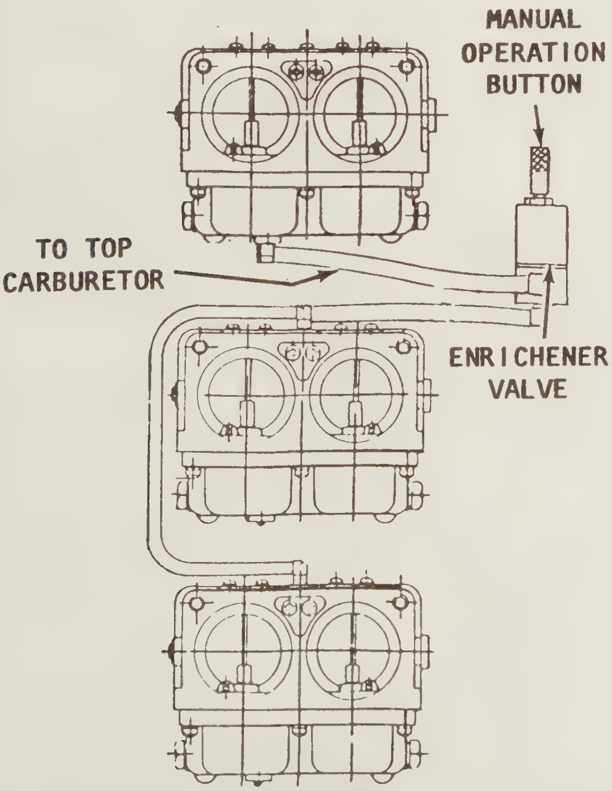




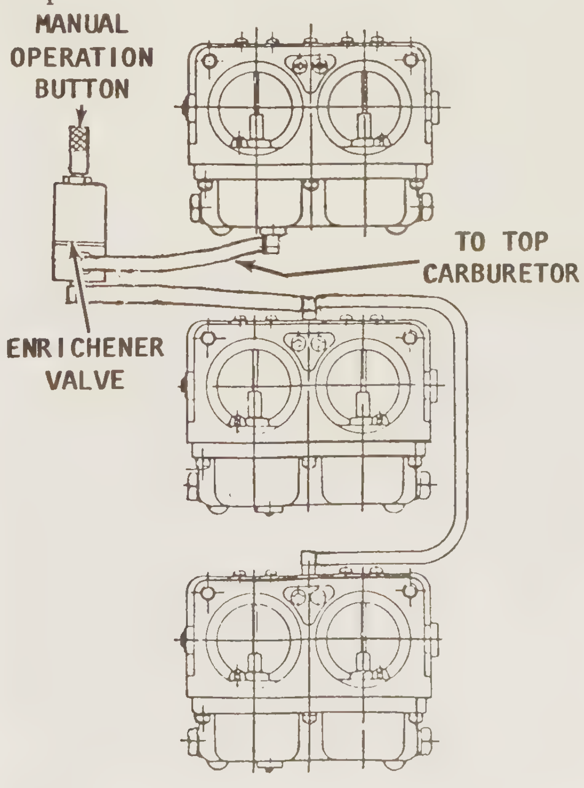
front of the carburetors. Align the holes in the plate with the carburetors. Install the six bolts through the attenuator plate, securing the plate to the carburetors.

11- Install the idle stabilizer on top of the attenuator plate. Route the wire harness down to the switch box. Connect the three or four wires from the idle stabilizer to the appropriate terminals on the switch box, as noted during removal. On the rear of the attenuator plate, connect the bleed hose to the fitting on the port side lower corner.

12- Install the sound box cover over the attenuator plate and secure the plate with two bolts. Connect the fuel line at the fuel tank and at the powerhead. Connect the battery leads to the battery terminals and perform the Timing and Synchronizing procedures presented in Chapter 6.



Enrichener valve and hose routing on the ***PORT*** *side of a V6 powerhead. The enrichener system performs a "choking" function.*



Enrichener valve and hose routing on the ***STARBOARD*** *side of a V6 powerhead.*

4-6 CARBURETOR "B" WALBRO WMH TWO BARRELS -- ONE FLOAT MODELS 135HP THRU 200HP 1991 AND ON

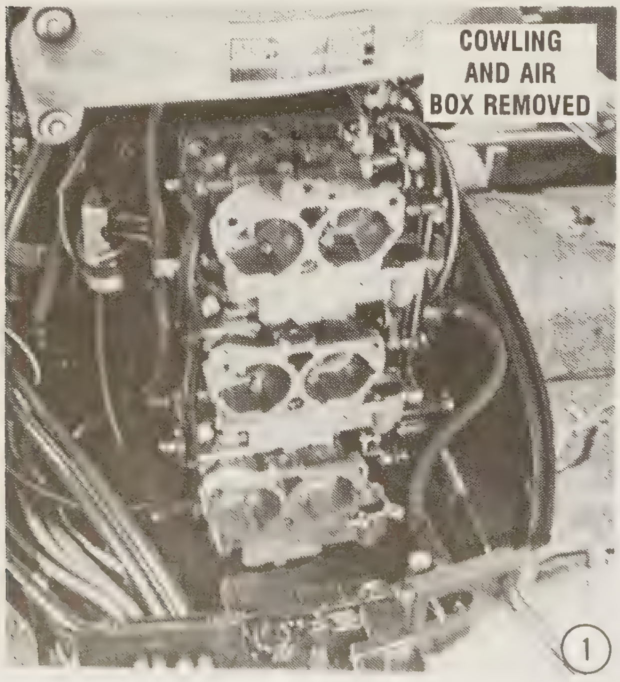
This section provides complete detailed illustrated service procedures to remove, disassemble, clean and inspect, assemble, make bench adjustments, install, and then make operating adjustment for the carburetor listed in the heading on the indicated V6 60° powerheads. Complete instructions to synchronize the fuel with the ignition system are given in Chapter 6.

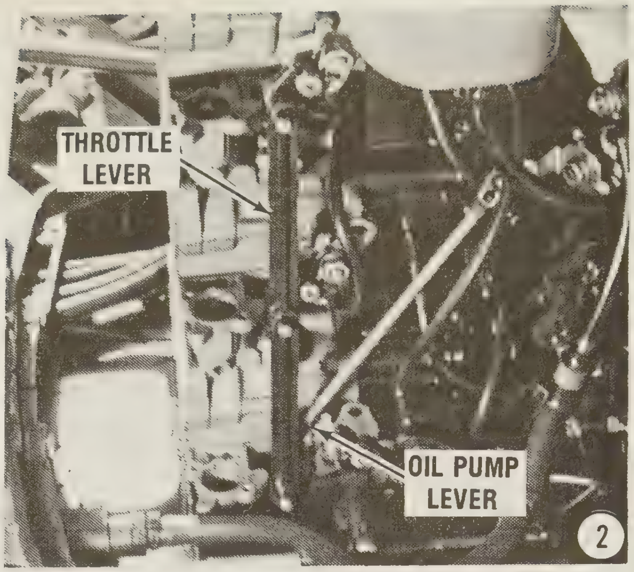
The WMH carburetor is the most popular model carburetor used on Mercury/Mariner V6 powerheads today. On 1991 production powerheads this carburetor utilized an accelerator pump circuit. The acceleration pump circuit was discontinued in 1992. The bore for the accelerator pump is sealed with a plug.

Three of these carburetors are installed on the powerhead and **MUST** remain in the exact position from where they are removed. The Top, Center and Bottom carburetors have different size main and vent jets. Therefore, identify each carburetor position prior to removal.

REMOVAL

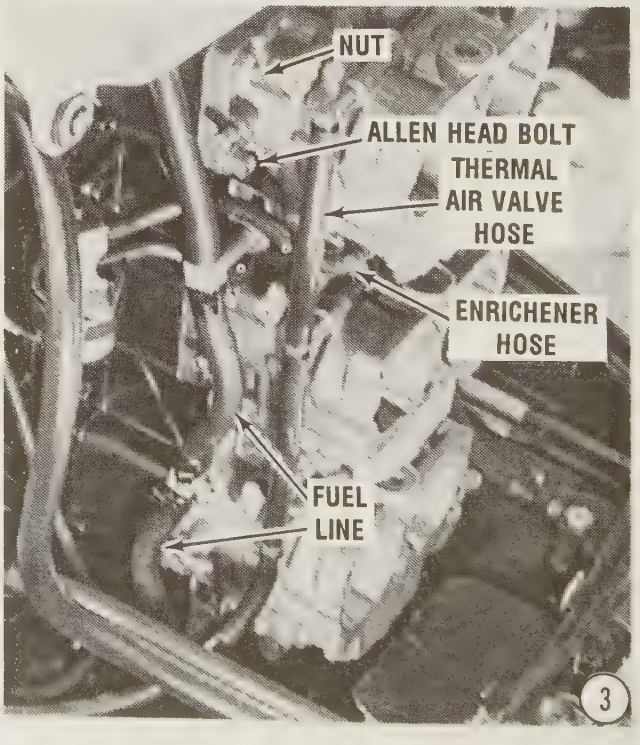
1- Unlatch and remove the cowling from the powerhead. Disconnect the battery leads from

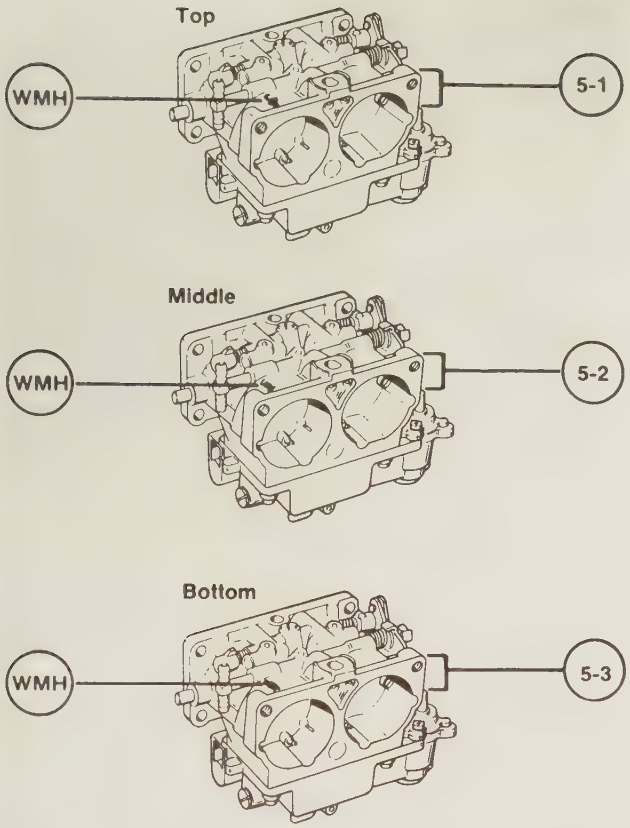




the battery terminals. Disconnect the main fuel line from the fuel tank and the powerhead. Remove the two screws securing the air box cover to the powerhead. Remove the six bolts securing the air box to the carburetors and lift the air box free of the powerhead.

2- Disconnect the throttle linkage from each carburetor throttle lever by inserting a flat blade screwdriver between the throttle lever and the nylon linkage arm. Pry the nylon linkage arm off the end of the throttle lever. Disconnect the oil pump link rod from the bottom carburetor throttle lever by prying the link arm off the ball stud on the throttle lever.





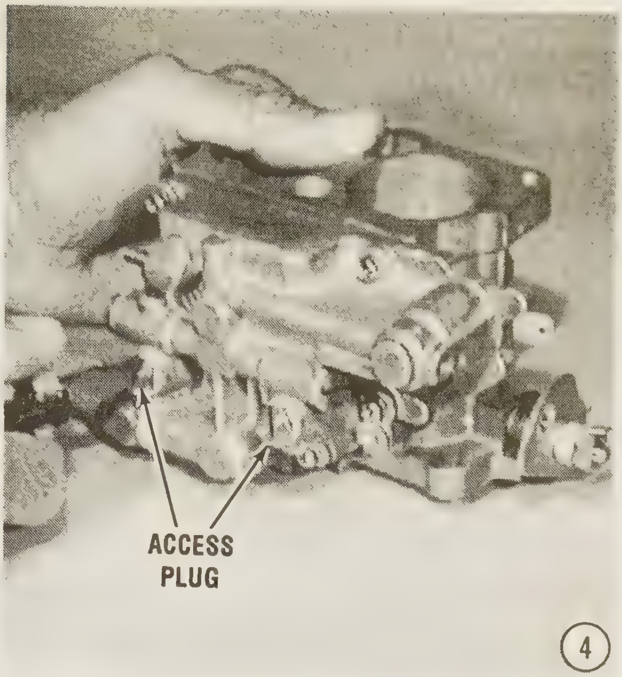
3- Loosen the clamps or cut the tie-straps and disconnect the fuel enrichment hoses, fuel lines and the thermal air valve hoses from the carburetor fittings. Mark each carburetor -- Top, Center and Bottom -- before removal to be sure each carburetor is installed back in its original position. Remove the two nuts and two Allen head bolts securing the carburetor to the intake manifold and lift the carburetor free of the powerhead. Discard the carburetor gasket.

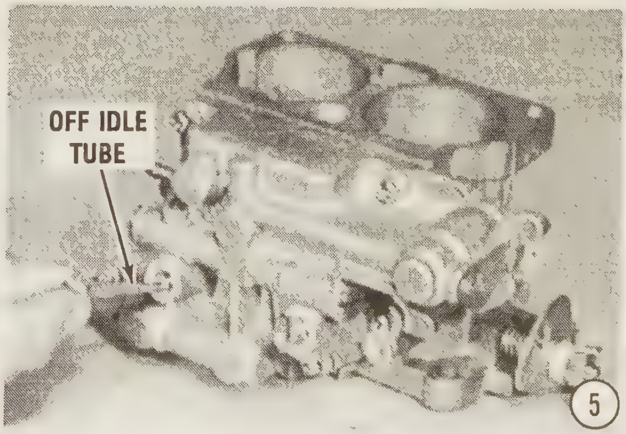
CARBURETOR IDENTIFI-CATION WORDS

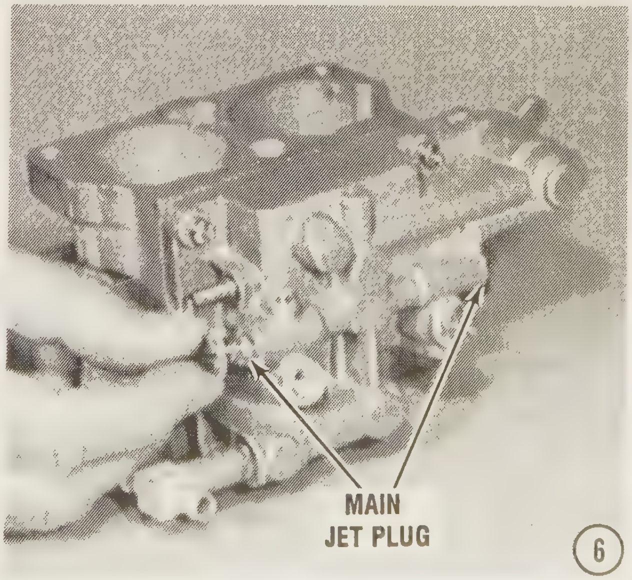
Proper identification of the carburetor by model number is critical when purchasing replacement parts. Without these numbers the dealer has no way of ordering the correct parts. The model WMH carburetor is identified on the starboard side of the main body by a single or double digit number, as shown in the accompanying illustration. If there is any doubt, take the carburetor to the dealer for his positive identification.

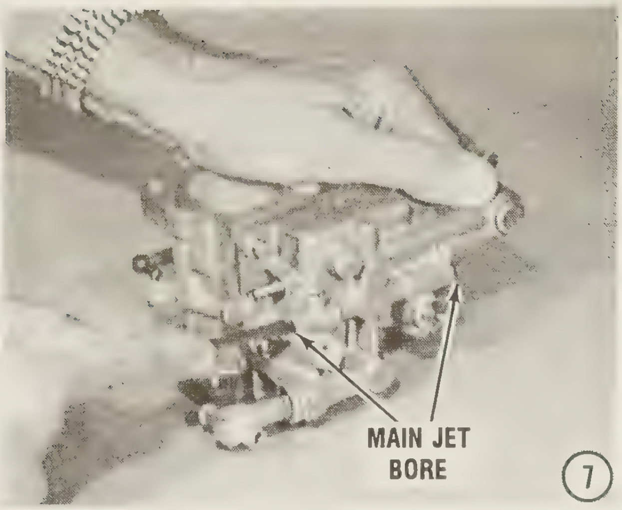
4- Loosen, and remove the off-idle tube access plug. Discard the gasket on the plug.

5- Insert a long flat blade screwdriver down inside the counterbore and unscrew the off-idle tube. Withdraw the off-idle tube from the bore and set the tube to one side. Repeat steps 4









and 5 to remove the other off-idle tube from the other side of the carburetor body.

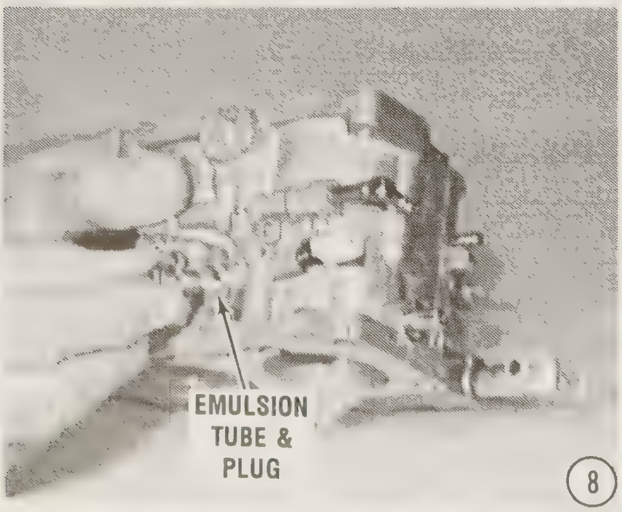
6- Loosen, and remove the main jet access plug. Discard the gasket on the plug.

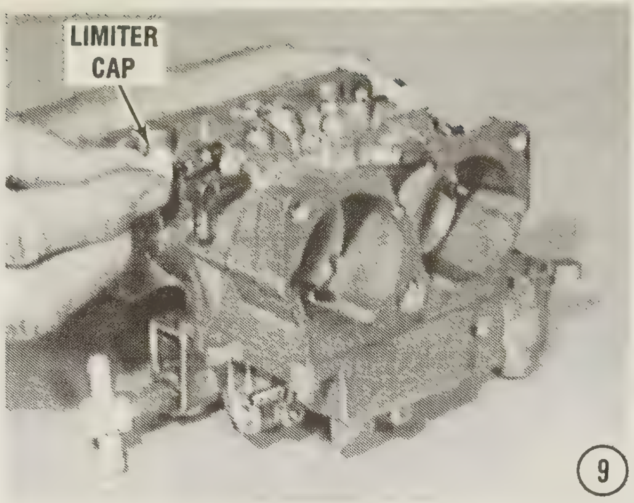
7- Insert a long flat blade screwdriver down inside the counterbore and unscrew the main jet. Withdraw the main jet from the bore. Set the jet to one side. Repeat Steps 6 and 7 to remove the other main jet access plug and main jet from the other side of the carburetor body.

8- Use a flat blade screwdriver, and remove the emulsion tube access plug on top of the carburetor. Pull the emulsion tube and plug from the carburetor. If only the plug comes out, the emulsion tube may be removed once the float bowl is removed.

NOW, THESE WORDS

Limiter caps are installed on the idle air mixture screw at the factory. The caps are necessary to prevent an over rich or too lean a fuel mixture, but do allow some movement for idle speed fuel mixture settings. If it is necessary to remove the idle mixture screws from the carburetor for proper cleaning, remove the limiter cap and turn the screw **CLOCKWISE,** and count the number of turns until it is lightly seated. The mixture screw **MUST** be set back to this number of turns from the lightly seated position when the limiter caps are installed.



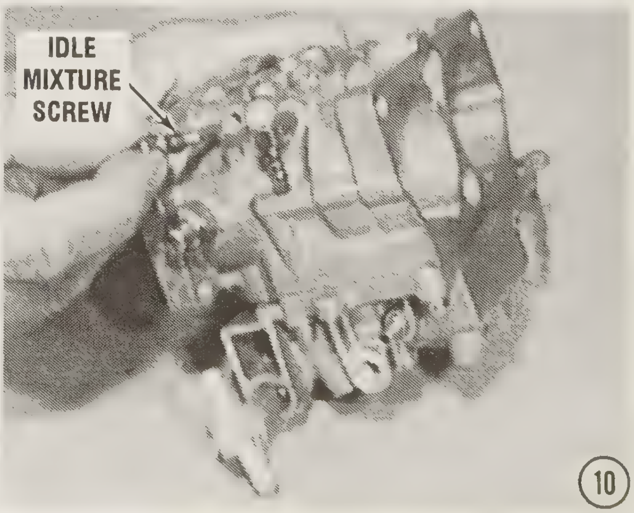


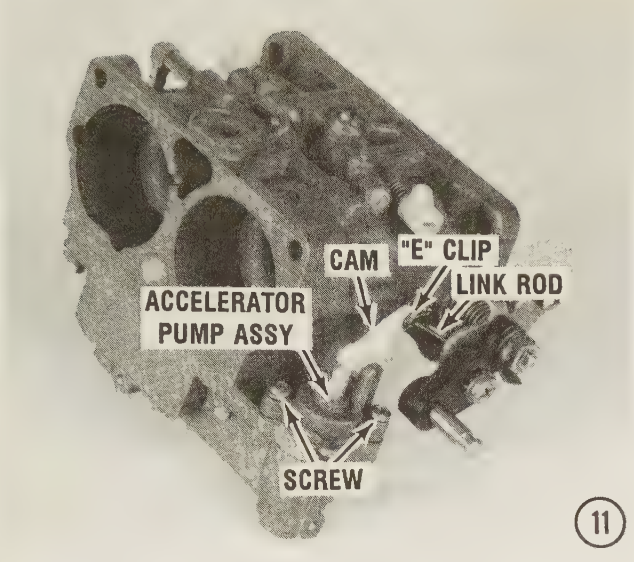
9- Slip the nylon limiter cap off the end of the idle mixture screw. Using a flat blade screwdriver turn the mixture screw **CLOCKWISE**, and count the number of turns until it is **LIGHTLY** seated.

10- Unscrew the idle mixture screw fully from the bore. Do not loose the spring over the screw shank. Repeat steps 9 and 10 for the other idle mixture screw on the other side of the carburetor.

Accelerator Pump Circuit - 1991 Models Only

This model year carburetor was equipped with an accelerator pump circuit. If the carbu-





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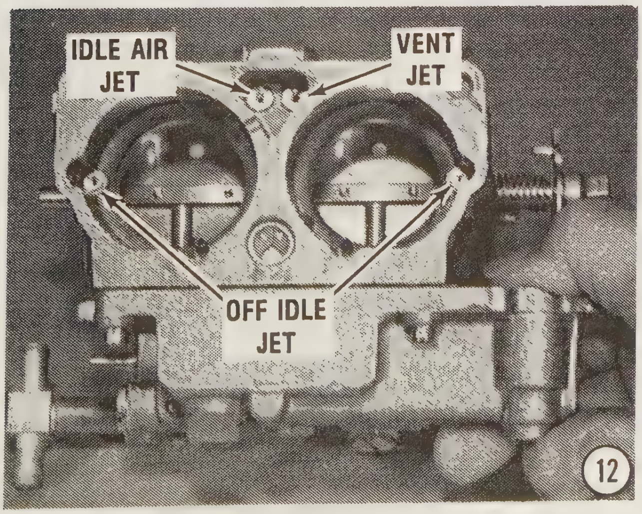
retor being serviced has this feature, proceed with the next step, otherwise proceed directly to Step 12.

11- Remove the "E" clip from the throttle cam link rod. Remove the Phillips head screws securing the accelerator pump assembly to the float bowl assembly. Lift off the accelerator pump assembly with the plunger from the float bowl. Remove the plunger return spring from the pump bore. Inspect the seal around the pump cup. If the pump cup seal is hard or damaged, replace the seal.

All Models

12- The two off-idle jets, idle air jets and the vent jets are all installed in the front of the carburetor body. If the carburetor is being disassembled only for general cleaning, and these jets are not to be replaced, it is recommended these jets not be disturbed and a good quality carburetor spray cleaner be applied. If the jets are being replaced, remove each jet using a flat blade screw driver.



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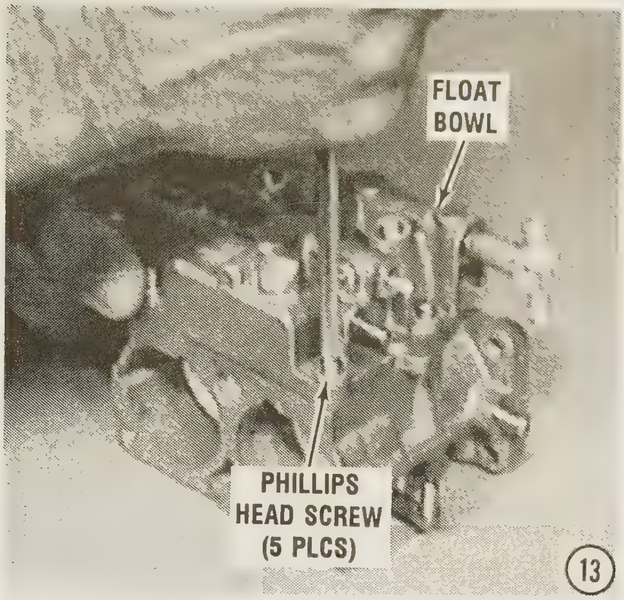

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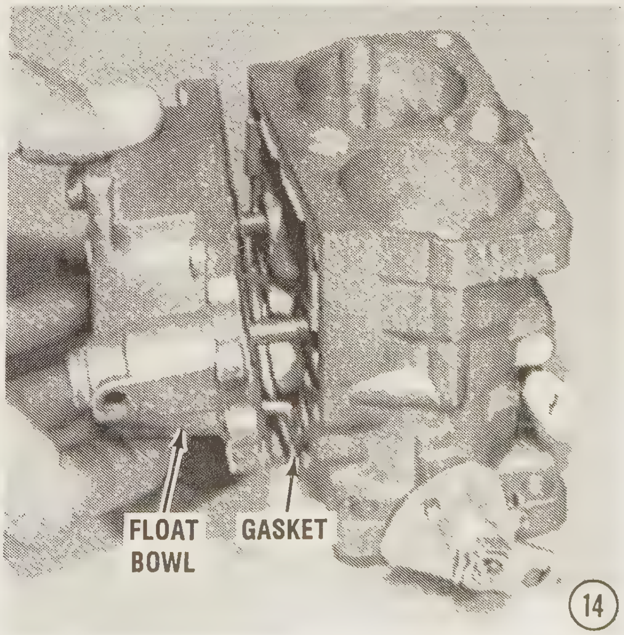
13- Remove the five Phillips head screws securing the float bowl to the carburetor main body.

14- Separate the float bowl from the main body and slide the bowl assembly free of the carburetor. Discard the gasket between the float bowl and main body.

15- Hold the float bowl carefully and remove the flat head screw securing the float pin to the bowl assembly.



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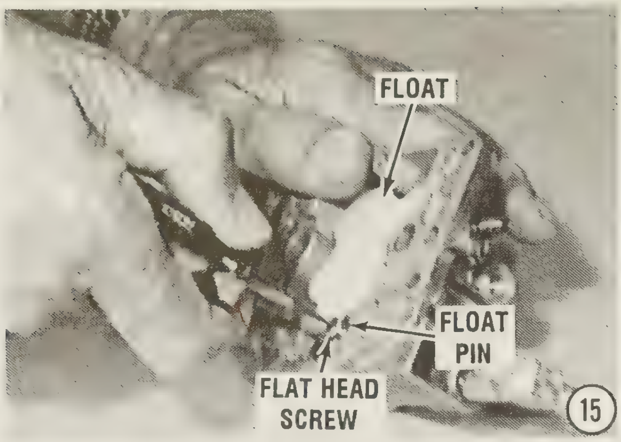
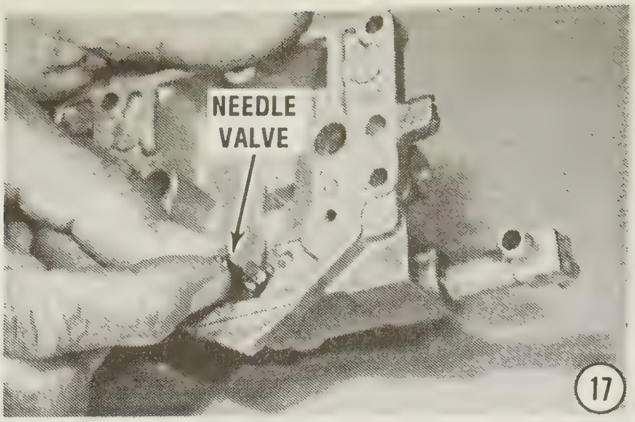


16- Lift out the screw, float and pin from the float bowl. Examine the float assembly for signs of cracking or saturation of fuel. Replace the float assembly if found to be defective.

17- Lift the fuel needle valve from the needle seat assembly. Examine the needle valve for signs of wear and deterioration. If the needle valve is worn, replace the needle valve and seat as an assembly. Discard the needle valve if a new assembly is to be installed.

18- Use a "wide" flat blade screwdriver and remove the needle valve seat from the bowl assembly. Discard the gasket on the valve seat. If a new needle valve and seat is to be installed, discard both the seat and gasket.

Push and pull on the throttle shaft, if there is sign of excessive "play" in the shaft, and/or the shutters are gouging the throttle bore heavily.

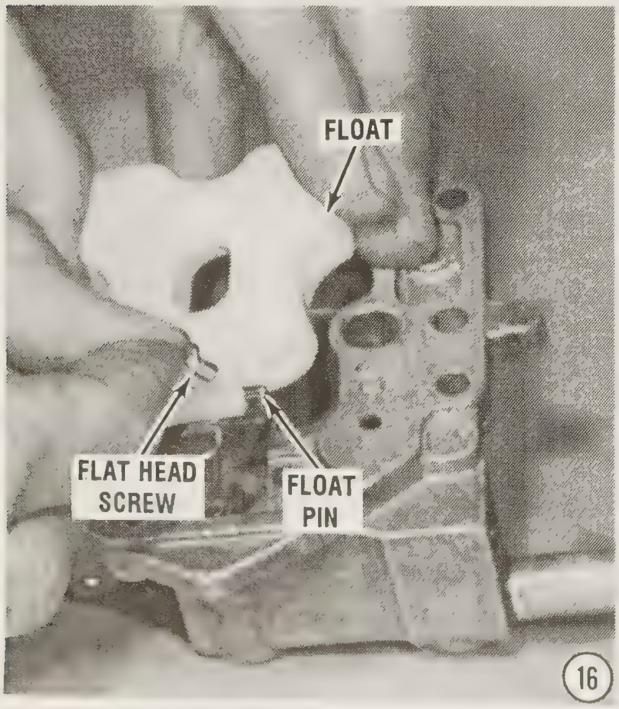


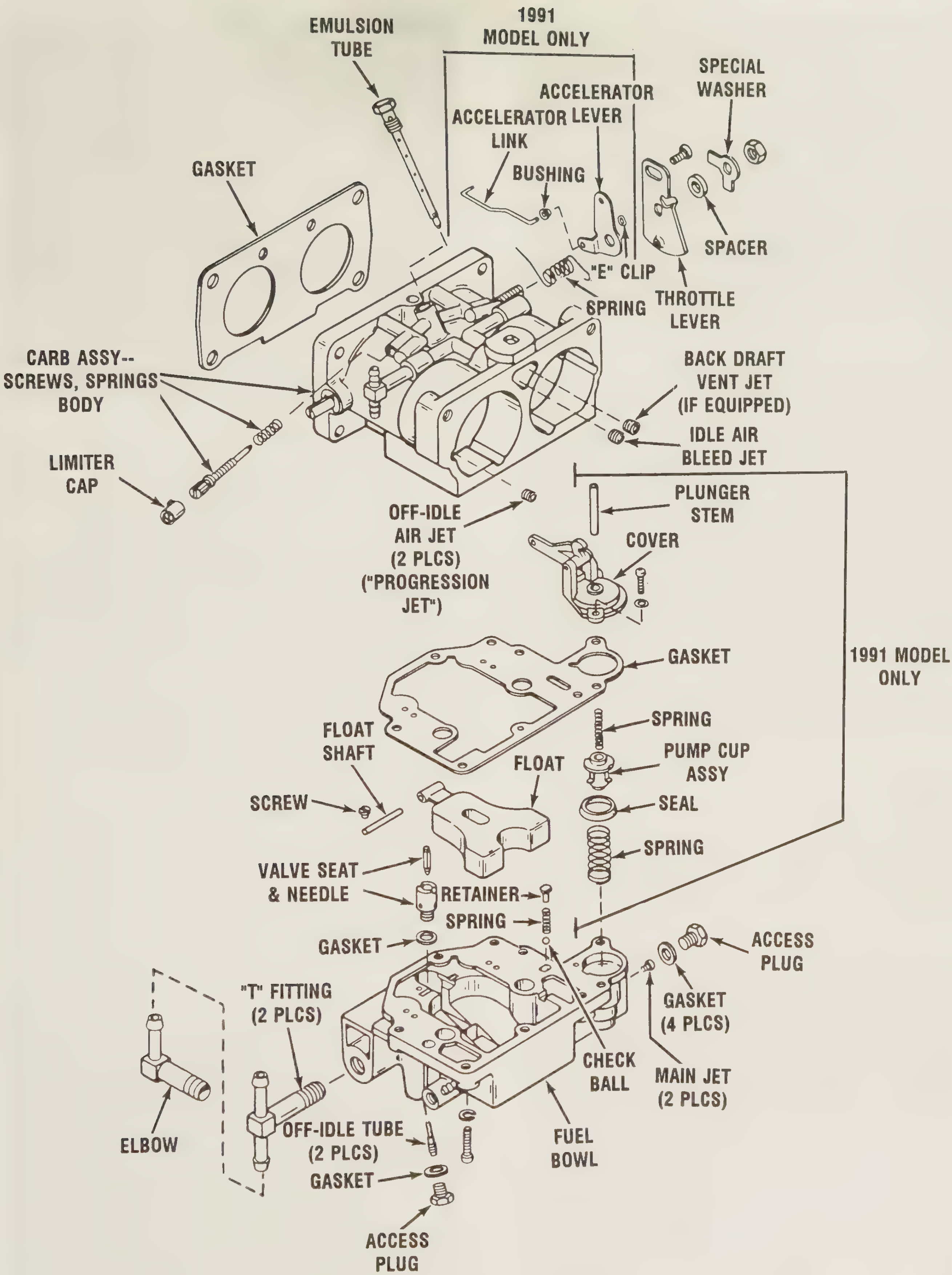
The throttle shaft and bushings are defective or worn and **MUST** be replaced.

GOOD WORDS

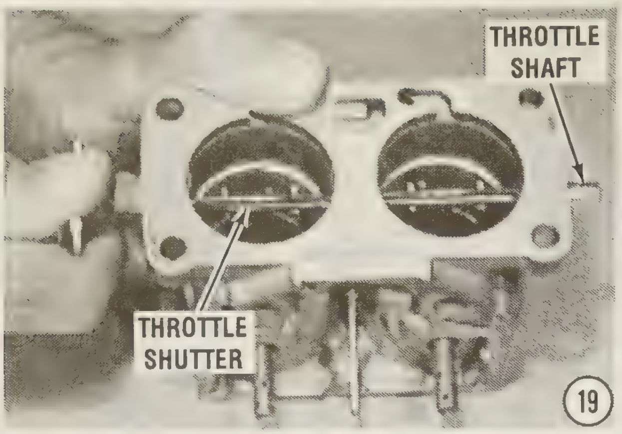
Further disassembly of the carburetor is not necessary in order to clean it properly. Normally it is not necessary to disassemble the throttle shutters unless there is excessive "play" or the shutters are binding. **BEFORE** disassembling the shutters and throttle shaft, **FIRST** check with the local dealer for parts availability. The shutters on some carburetor models cannot be serviced as individual parts. In some cases the throttle body **MUST** be replaced.

19- Operate the throttle shutters open and closed several times checking for any sticking or binding action. If the throttle shutters show any sign of binding or sticking they **MUST** be replaced.





*Exploded drawing of Carburetor "**B**" -- Walbro WMH -- with major parts identified.*



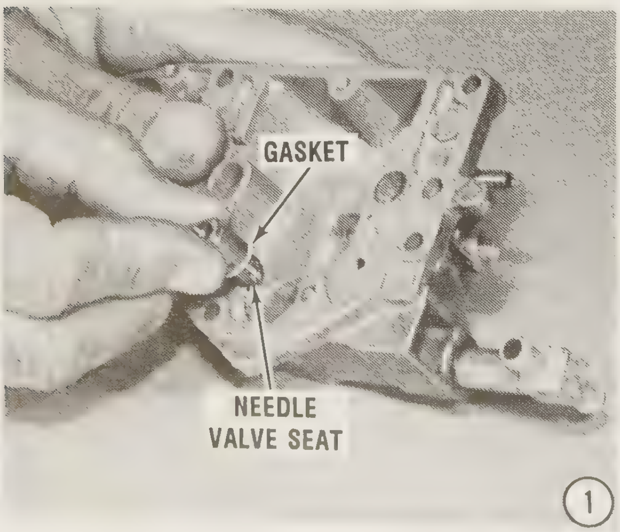
CLEANING AND INSPECTING

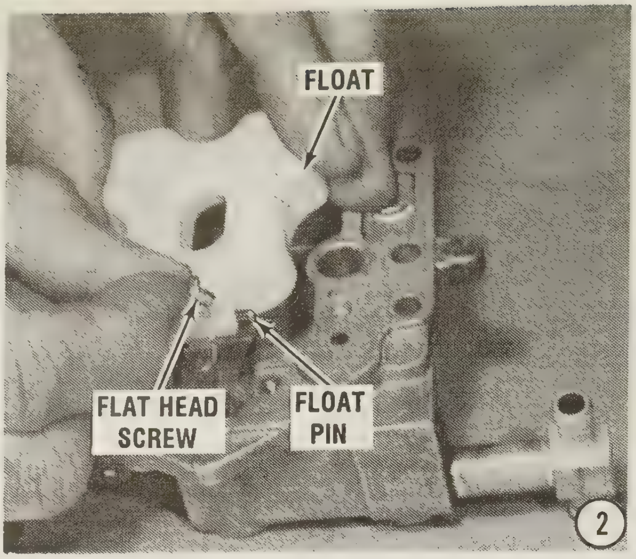
NEVER dip rubber, plastic, or nylon parts into liquid automotive type cleaners. Many of these "dip" cleaners are highly toxic, and **DANGEROUS.** Use only a high quality "Choke and Carburetor" spray type cleaner.

Spray all metal parts and passages thoroughly with a spray cleaner, and then blow them dry with compressed air. Repeat spraying with cleaner until all traces of dirt, gum and varnish is removed. A medium to stiff bristle brush may be used to loosen stubborn dirt and gum deposits. **BE SURE** to blow all passages thoroughly dry with compressed air.

ASSEMBLING

1- Slip a new gasket over the threaded end of the fuel valve seat. Install the seat into the float bowl assembly. Use a "wide" blade screwdriver to tighten the valve seat.





2- Insert the needle valve into the seat and then install the float and float pin. Be sure to center the float pin into the recess of the float bowl. Install the flat head screw to secure the float.

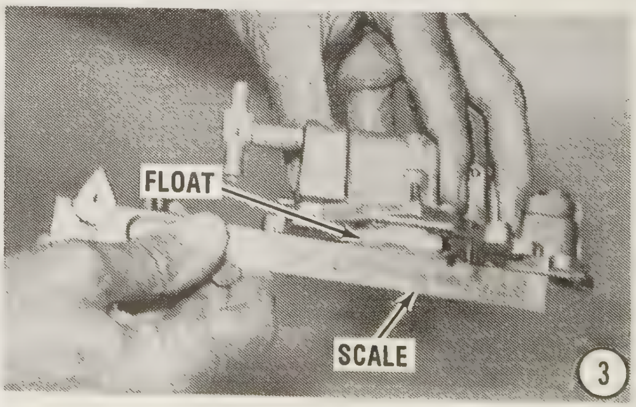
3- Pick up the float bowl and invert the assembly to allow the float to hang free. Place a machinist scale across the flat surface of the float bowl directly under the float. The correct float height is the float just making contact with the scale but the float does not drop below the horizontal surface of the float bowl.

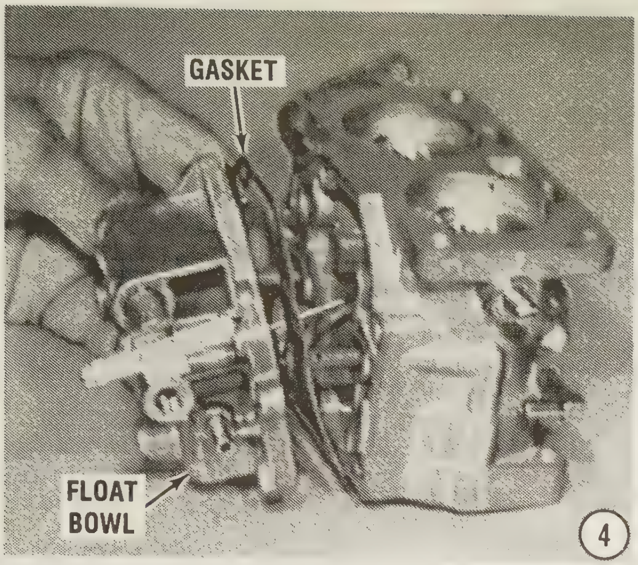
If the float height is not correct, **CAREFULLY** bend the small metal tab on the tip of the float to adjust the float height.

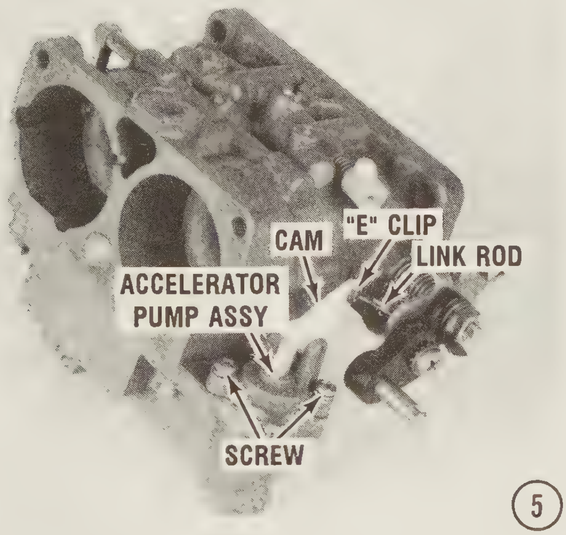
4- Place a new gasket over the float bowl. Guide the float bowl onto the carburetor body. Secure the float bowl to the carburetor body with five Phillips head screws.

Accelerator Pump Circuit 1991 Models Only

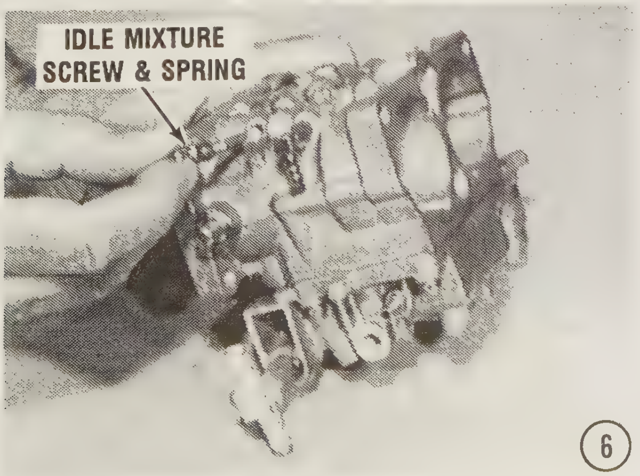
If the carburetor being serviced has this feature, proceed with the next step, otherwise proceed directly to Step 6.

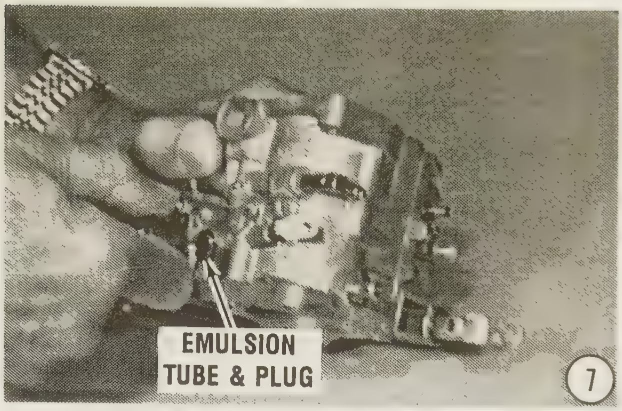






5- Install a new seal onto the pump cup. Insert the plunger stem and small spring into the pump cover. The tip of the plunger **MUST** contact the tip of the lever. Insert the large spring into the accelerator pump bore. Lower





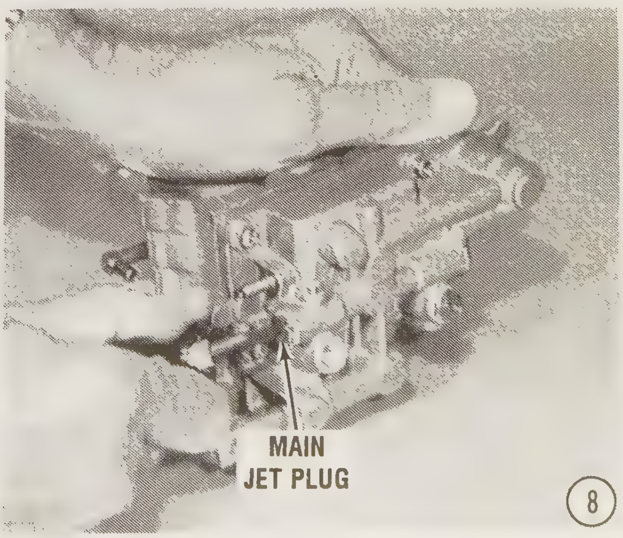
the pump cover onto the fuel bowl and secure the cover with two Phillips head screws. Connect the throttle cam link rod between the pump lever and throttle cam lever, secure the link rod with the "E" clip.

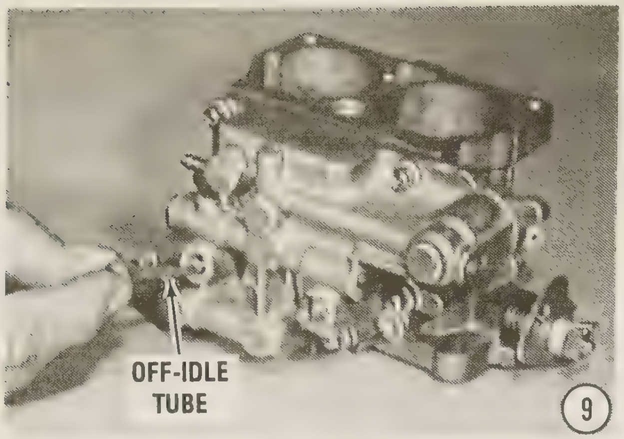
All Models

6- Thread the idle mixture screw and spring into the bore. Turn the mixture screw all the way down until it is **LIGHTLY** seated. Back out the mixture screw the exact number of turns recorded during disassembly. If the count was lost or not remembered, back it out 1-1/2 turns as a "rough" bench adjustment at this time. Fit the limiter cap over the end of the screw at approximately the 12 o'clock position. Repeat this step for the other idle mixture screw.

7- Insert the emulsion tube and cap plug into the top of the carburetor body. Tighten the emulsion tube plug securely.

8- Install the main jet into the bore using a long narrow screwdriver. Be careful not to cross thread the jet. Place a new gasket over the end of the access plug, and then install the





plug and tighten it securely. Repeat this step for the other main jet and access plug.

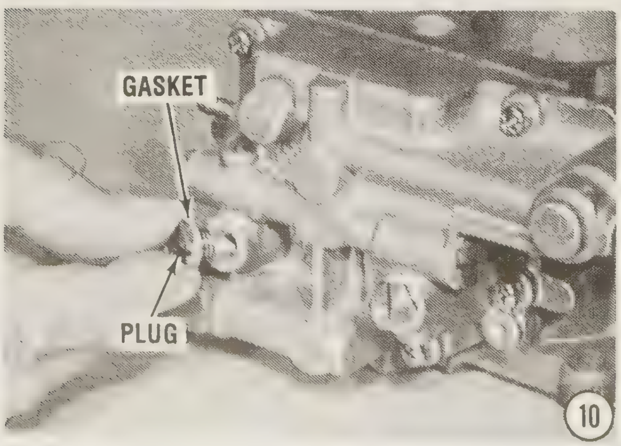
9- Insert the off-idle tube into the bore. Using a flat blade screwdriver, screw the tube into the bore until it is seated, and then tighten the tube securely.

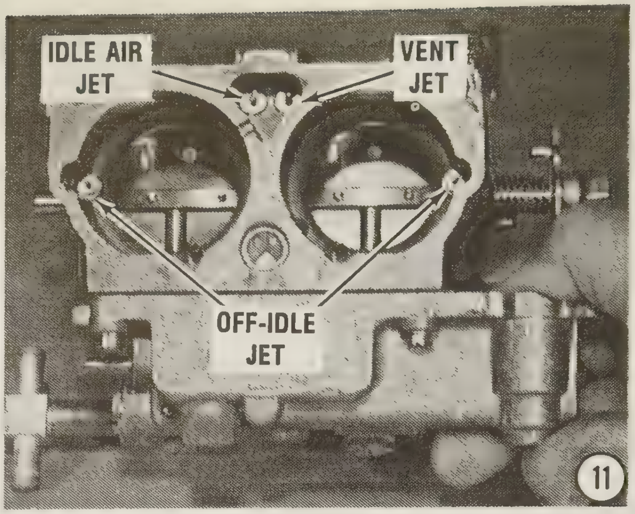
10- Place a new gasket over the end of the off-idle tube access plug. Install and tighten the access plug. Repeat steps 9 and 10 for the other off-idle tube.

11- Install the off-idle jets, idle air jet and vent jet, if any were removed during the disassembly procedures. Be sure to install the proper size jet for the carburetor model. Refer to the jet size chart in the Appendix.

INSTALLATION

12- Position a new carburetor gasket onto the intake manifold studs. Install the carburetor in the same position from which it was removed -- Top, Center and Bottom -- as identified during the removal procedures. Secure each carburetor to the powerhead with the two nuts and two Allen head screws. Connect the fuel enrichment hoses, fuel lines and the thermal air valve hoses to the carburetor fittings. Secure the lines and hoses with clamps or tie-straps.



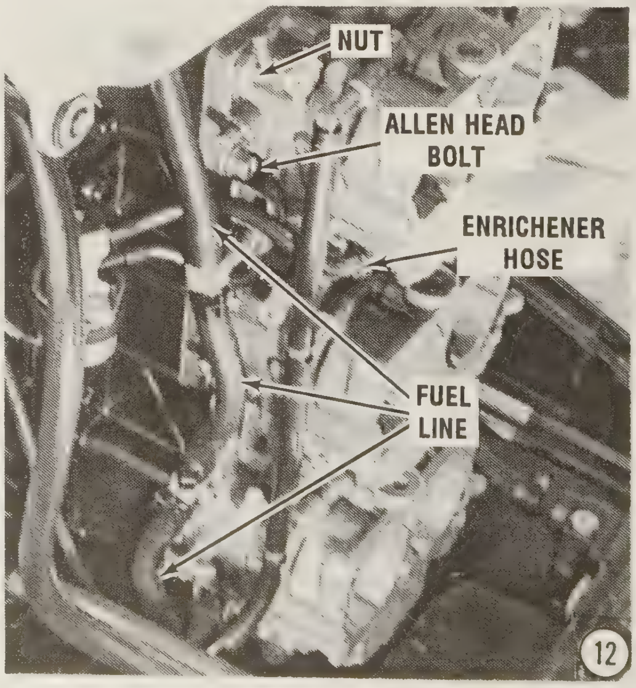


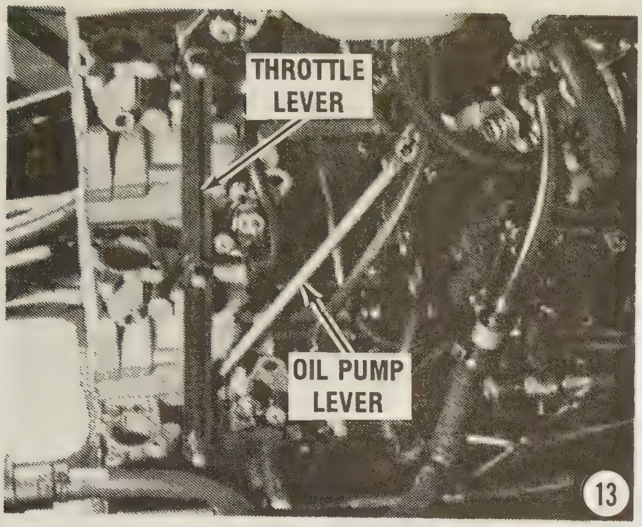
13- Connect the throttle linkage to each carburetor throttle lever by pushing the nylon linkage arm onto the end of the throttle lever. Connect the oil pump link rod to the bottom carburetor throttle lever by pushing the link arm onto the ball stud on the throttle lever.

14- Install the air box over the carburetors, aligning the holes in the cover with the carburetors. Secure the air box to the carburetors with six bolts and tighten the bolts securely. Connect the main fuel line to the fuel tank and the powerhead. Connect the battery leads to the battery terminals.

OPERATING WORDS

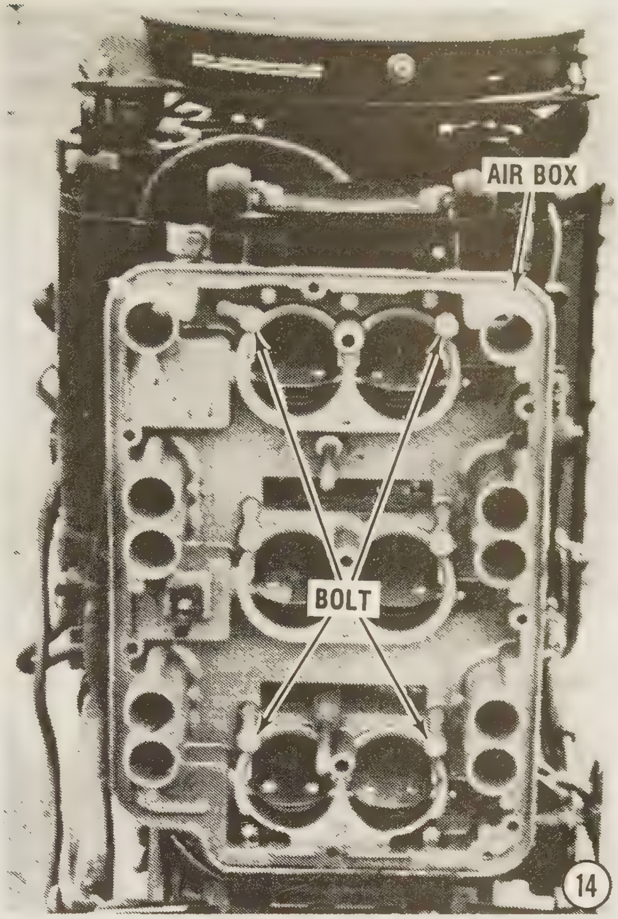
When operating the outboard for the first time following a carburetor overhaul, **BE SURE**

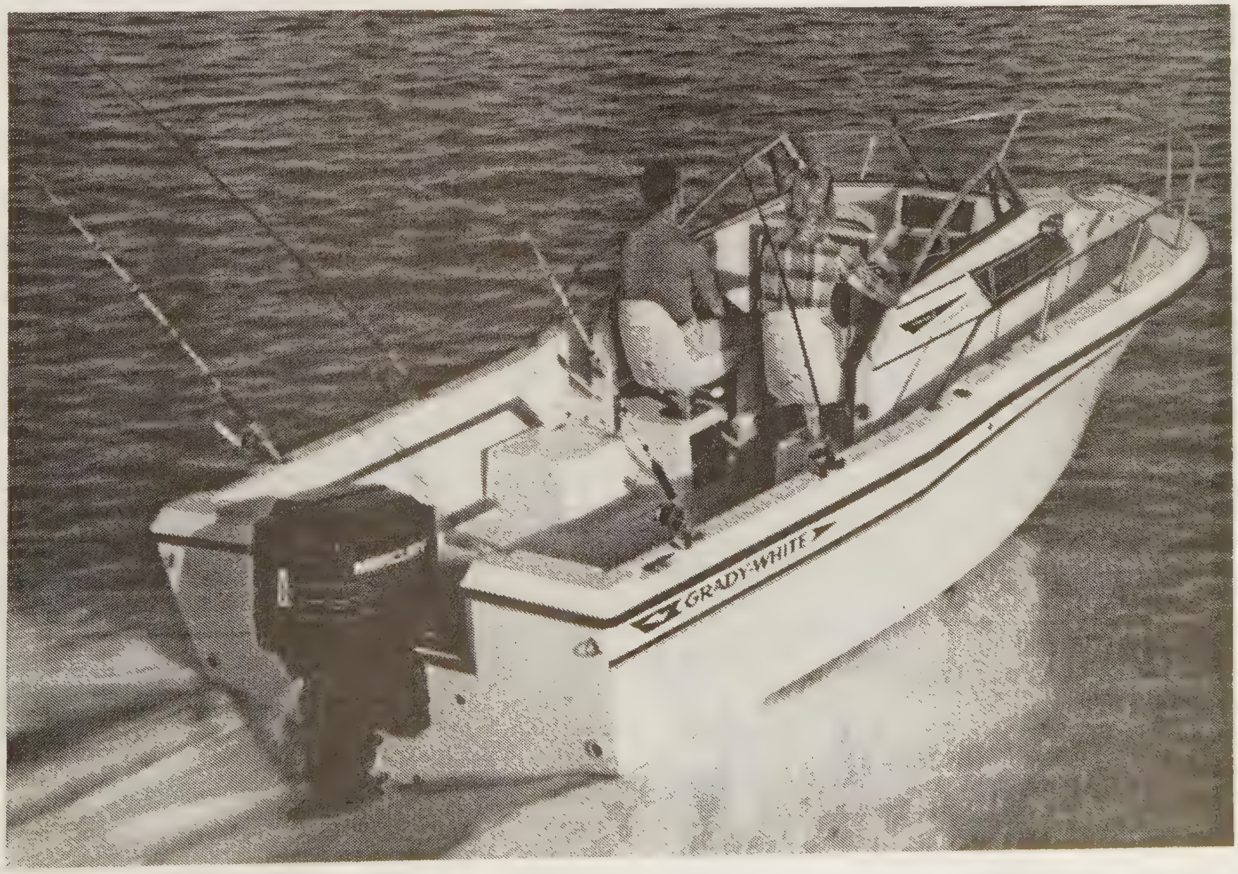


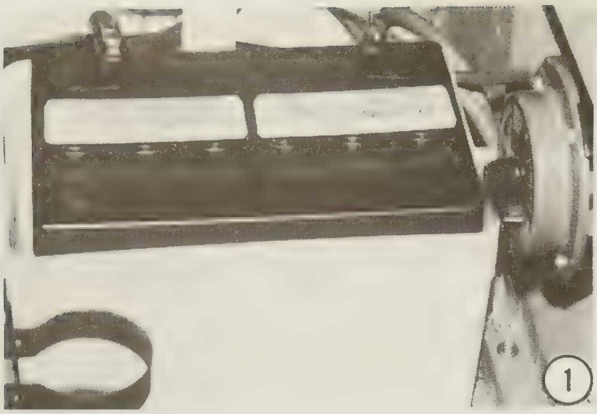


to check **ALL** fuel line connections and the carburetor float bowl seams for any sign of fuel leakage. With the powerhead operating, check for fuel dribbling from the carburetor vent tube. Fuel leaks from the vent tube, and float bowl seams indicate the float level is not set properly or a needle valve is sticking.

Perform the Carburetor Synchronizing procedures in Chapter 6. After the powerhead has been operated and verified no fuel leaks exist, install the air box cover and secure it with the two screws. Install the cowling over the powerhead and latch it closed.







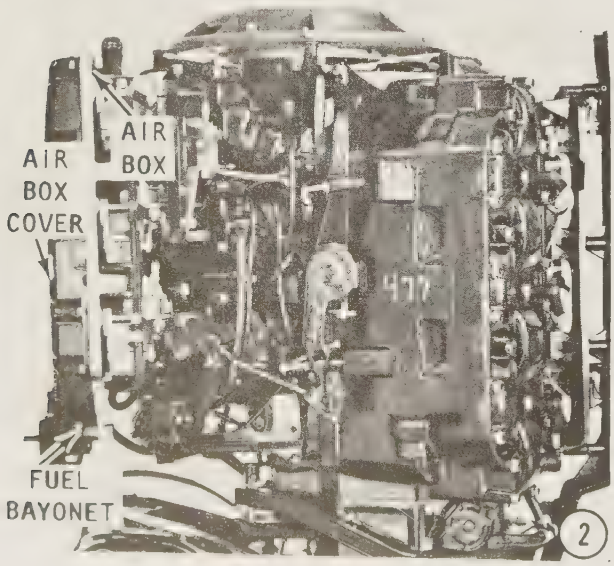
4-7 CARBURETOR "C" WALBRO WMO SINGLE BARREL -- DUAL FLOAT WITH SINGLE BOWL MODEL 275HP -- 1991 AND ON

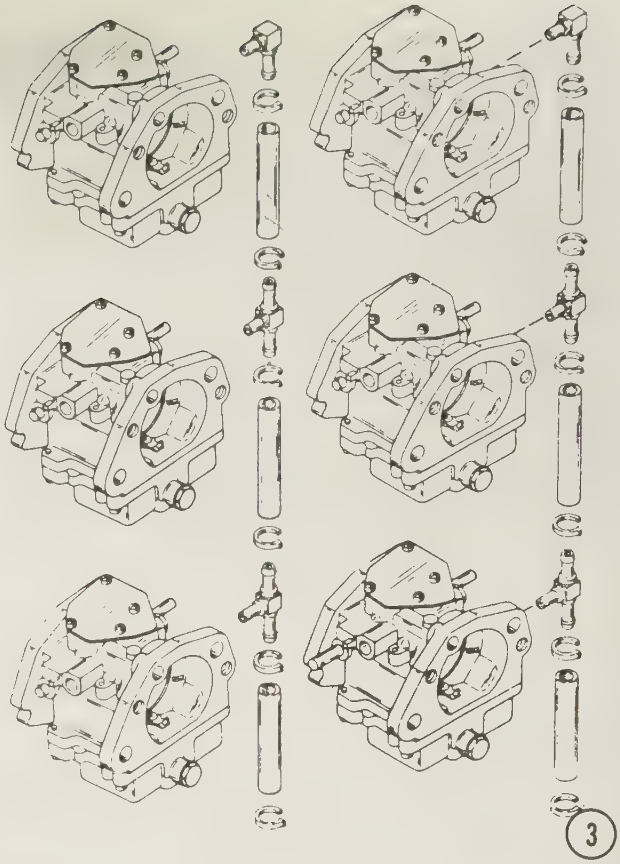
This section provides complete detailed illustrated service procedures to remove, disassemble, clean and inspect, assemble, make bench adjustments, install, and then make operating adjustment for the carburetor listed in the heading on the indicated V6 74° powerhead. Complete instructions to synchronize the fuel with the ignition system are given in Chapter 6.

REMOVAL AND DISASSEMBLING

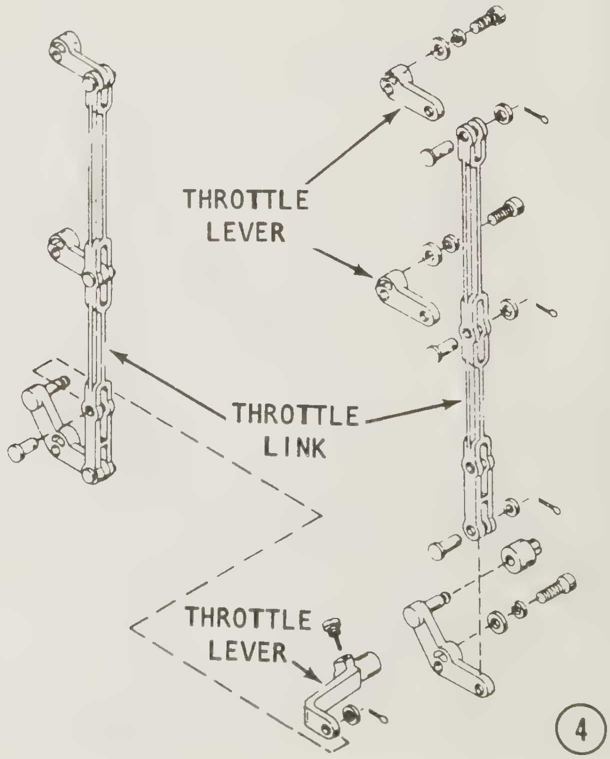
1- Remove the battery leads from the battery terminals. Remove the front powerhead cowling. Take off the wrap around cowling.

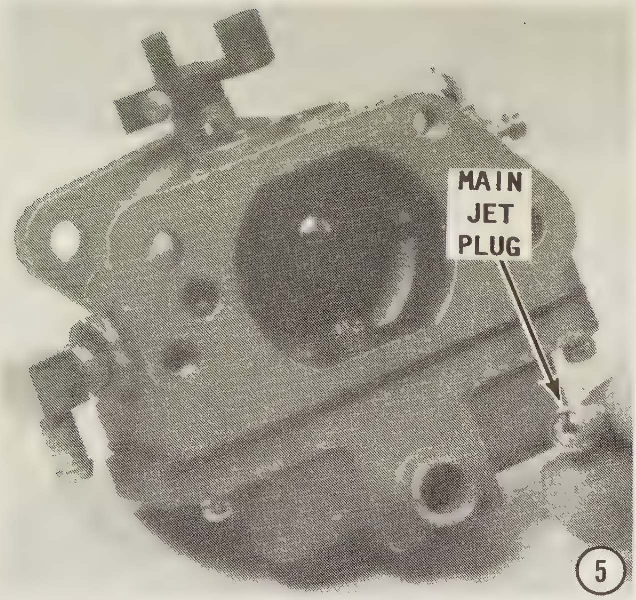
2- Release the fuel bayonet from the bracket on the air box cover. Remove the wing nuts securing the air box cover and lift the cover and air box from the carburetors. Remove the gasket from each carburetor.





3- Disconnect the fuel line from the powerhead. Remove the hose clamps on each fuel line to each carburetor. Disconnect the fuel line from each carburetor. Disconnect the enrichener valve hose fitting on the top port carburetor.

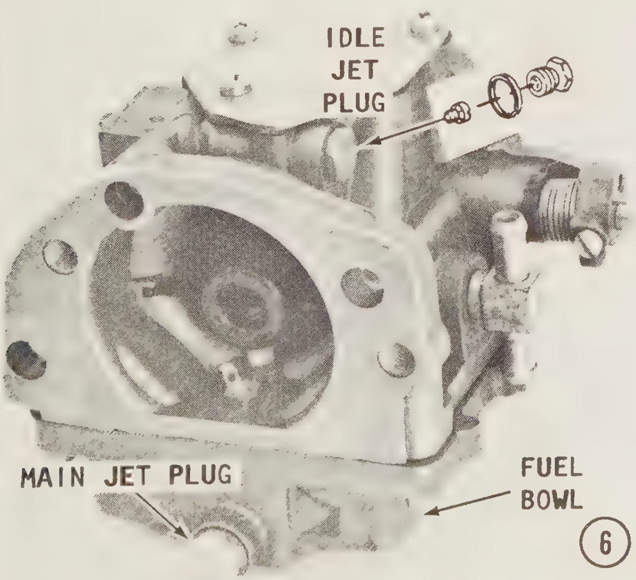


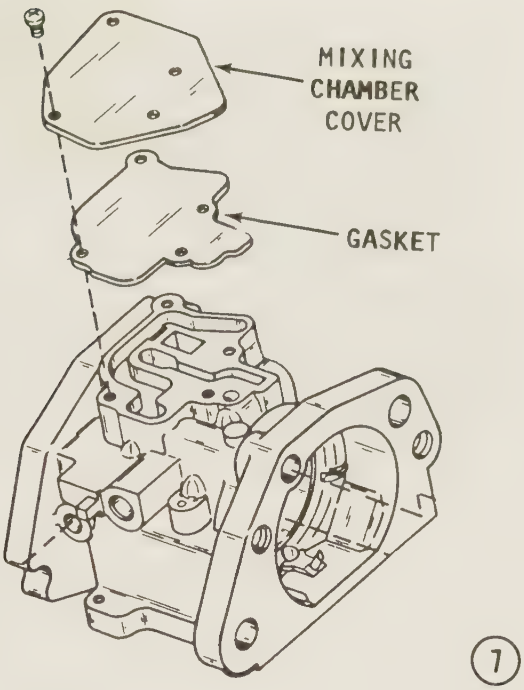


4- Disconnect the throttle linkage from each carburetor. **TAKE TIME** to identify each carburetor to **ENSURE** each will be installed back in its original position. The jets are different in the top, center, and bottom carburetors and the jets may differ from port and starboard carburetors.

Remove the attaching nuts securing each carburetor to the intake manifold. Remove each carburetor from the engine. Since the carburetors are identical, the following procedures are to be repeated for each carburetor.

5- Remove the main jet plug located in the bottom of the carburetor bowl. **NOTE** how the main (high-speed) jet is located inside the plug. The jet may be removed, using the **PROPER** size screwdriver.

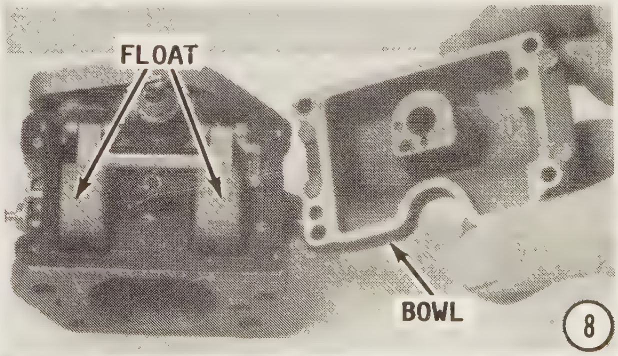


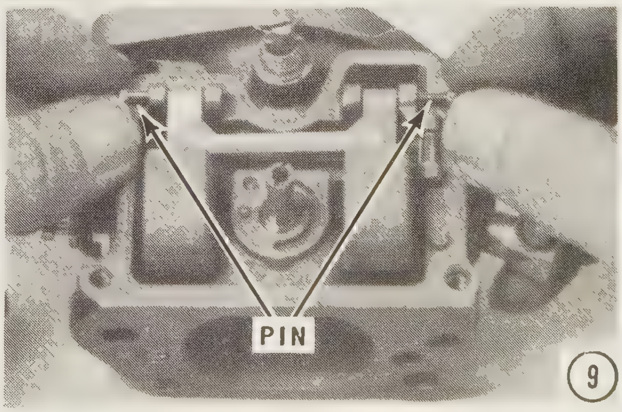


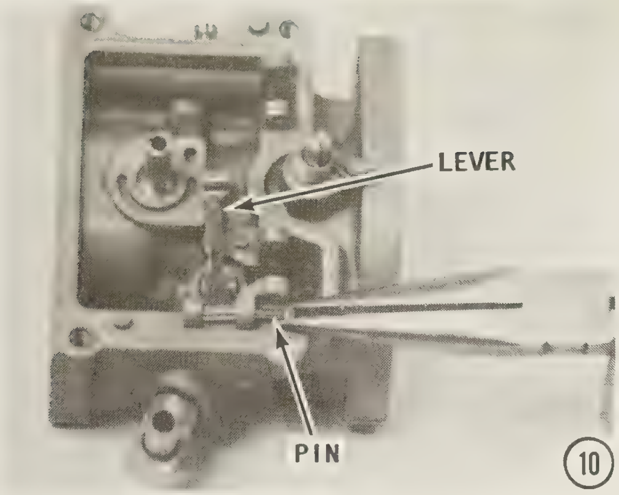
6- Remove the idle jet plug, gasket and idle jet, from the carburetor body.

7- Remove the five screws securing the mixing chamber cover. Lift off the cover and gasket.

8- Turn the carburetor upside down and remove the four screws securing the bowl to the body. Remove the bowl, and then remove and **DISCARD** the bowl to body gasket.







9- Observe how the float is a double unit with two hinge pins. Withdraw both hinge pins by pushing each toward the **OUTER** edge of the carburetor. After the pins are free, lift the float from the carburetor body.

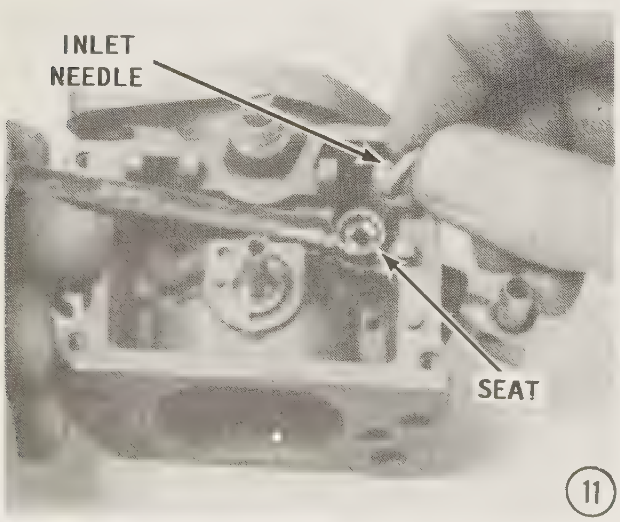
10- Remove the pin securing the float lever to the carburetor body by pushing the pin toward the backside of the carburetor. Remove the lever.

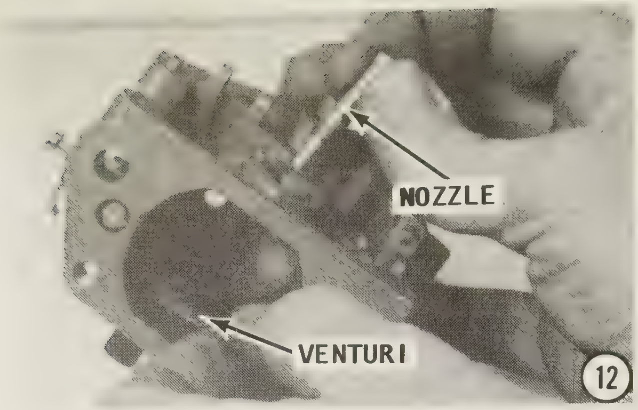
11- Withdraw the inlet needle from its seat. Remove the seat and the metal gasket installed below the seat.

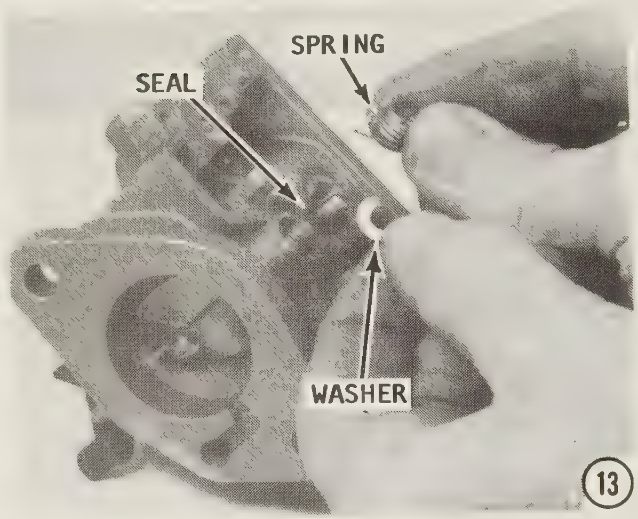
12- Remove the nozzle in the center of the carburetor body and at the same time observe that the venturi in the bore will now be loose. After the nozzle is out, remove the venturi from the carburetor bore.

13- Remove the throttle return spring, flat washer, and rubber seal from the bottom side of the carburetor.

14- Remove the fuel bowl vent jet from the port side.



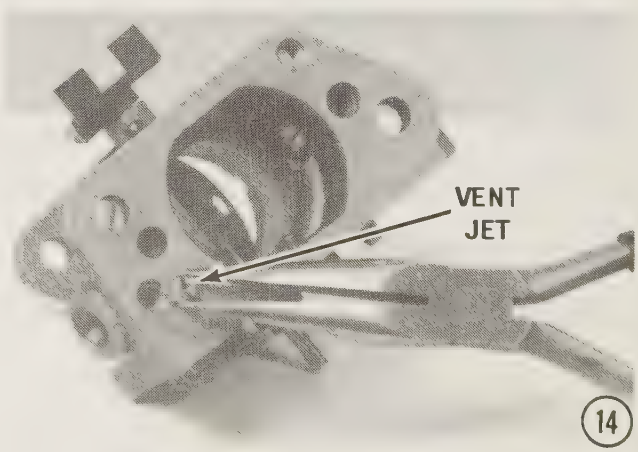


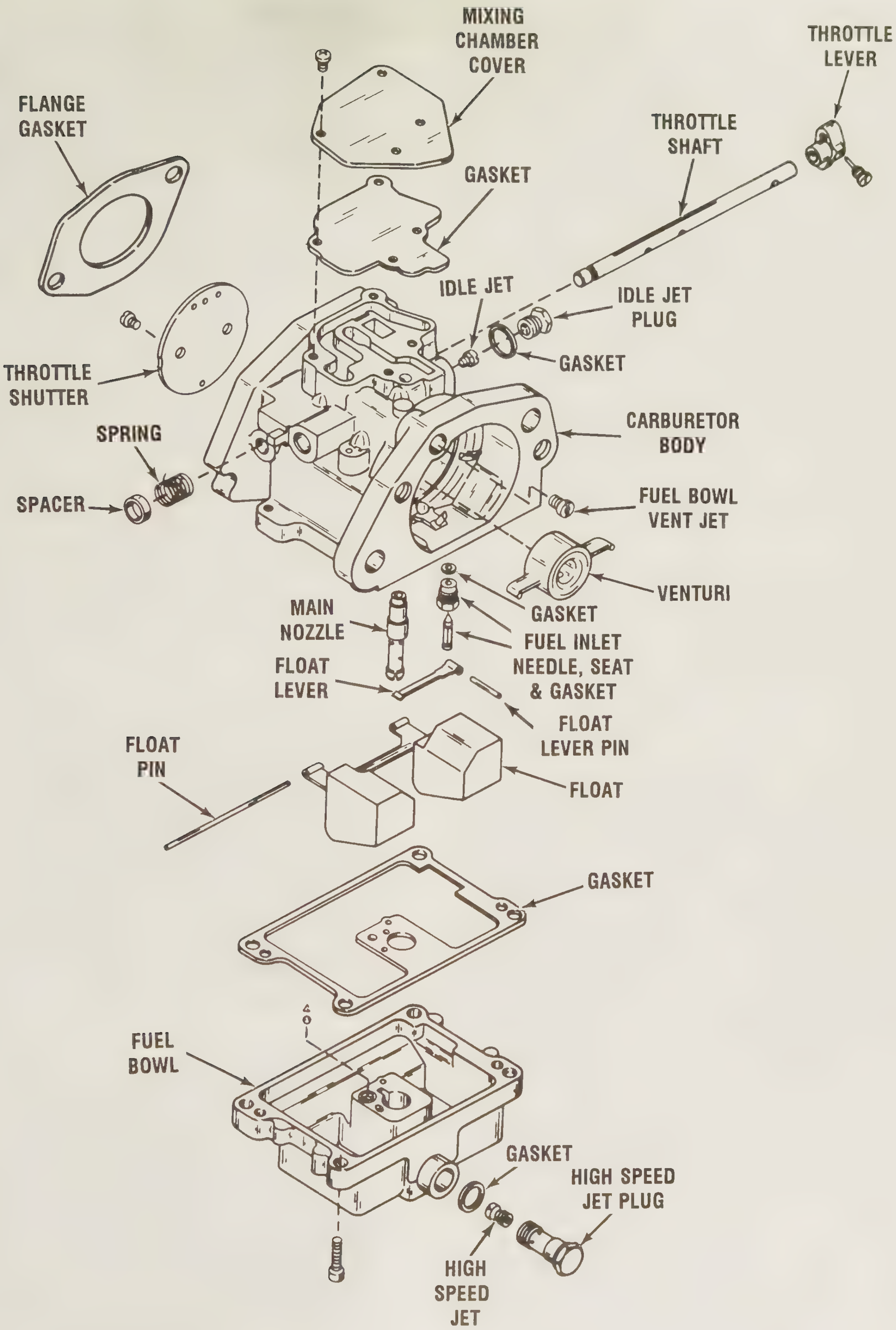


TAKE TIME to note the size and location of each jet during disassembling. All three jets, the main jet , the idle jet, and the vent jet, are easily accessible without disassembling the carburetor. These jets take the place of exterior carburetor adjustment screws used on earlier carburetors.

A GOOD WORD

Further disassembly of the carburetor is not necessary in order to clean it properly.





Exploded drawing of Carburetor "C" -- Walbro WO -- with major parts identified.

CLEANING AND INSPECTING

NEVER dip rubber, plastic, or nylon parts into liquid automotive type cleaners. Many of these "dip" cleaners are highly toxic, and **DANGEROUS.** Use only a high quality "Choke and Carburetor" spray type cleaner.

These new spray type cleaners are available at almost any parts house and are not expensive. Spray the metal parts with the cleaner and then blow them dry with compressed air.

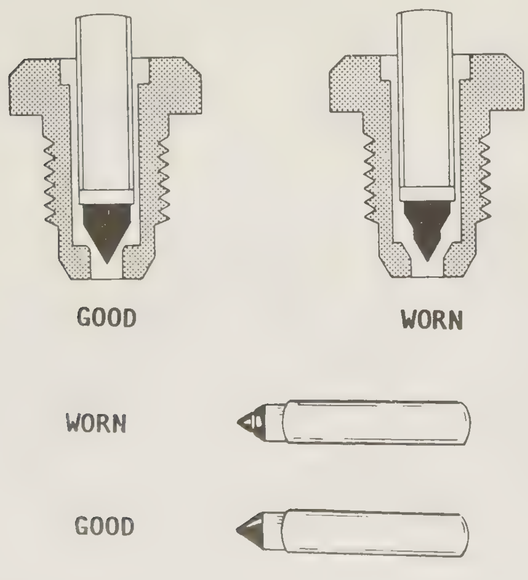
Blow out all passages in the castings with compressed air. Check all parts and passages to be sure they are not clogged or contain any deposits. **NEVER** use a piece of wire or any type of pointed instrument to clean drilled passages or calibrated holes in a carburetor.

Move the throttle shaft back and forth to check for wear. If the shaft appears to be too loose, replace the complete throttle body because individual replacement parts are **NOT** available.

Inspect the main body, airhorn, and venturi cluster gasket surfaces for cracks and burrs which might cause a leak. Check the floats for deterioration. If hollow floats are used, check to be sure they do not contain any fluid. If any part of the float is damaged, the unit must be replaced. Check the float lever to needle contacting surface and replace the float if this surface has a groove worn in it.

Most parts that should be replaced during a carburetor overhaul are included in an overhaul kit available from the local marine dealer. This kit will also contain a matched fuel inlet needle and seat. The combination should be replaced each time the carburetor is disassembled as a precaution against leakage.

Refer to the Carburetor Jet Size/Elevation Chart in the Appendix for the proper size for the powerhead being serviced, carburetor, and anticipated elevation of operation.

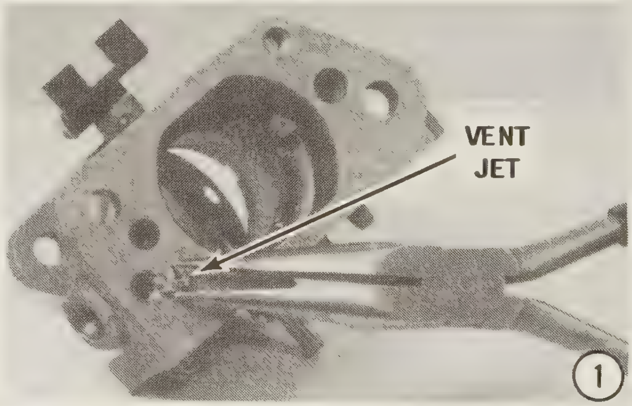


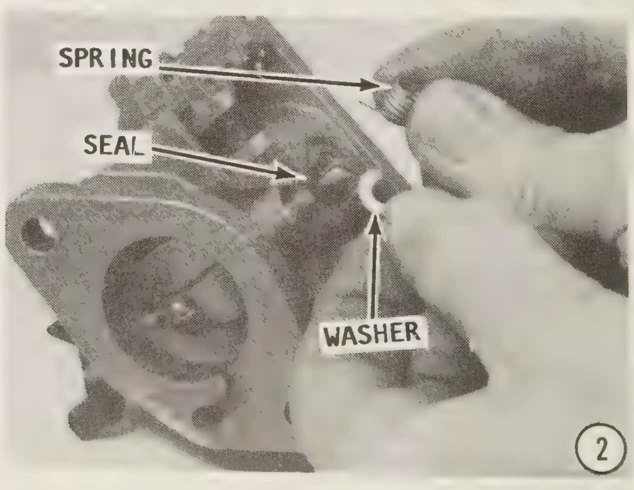
Needle and seat arrangement on the carburetor covered in this section, showing a worn and new needle for comparison.

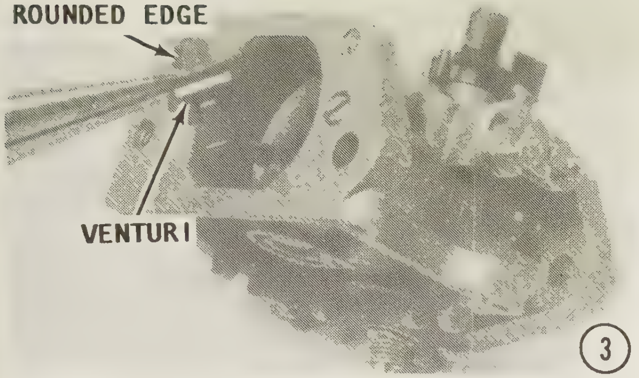
ASSEMBLING AND INSTALLATION

1- Install the fuel bowl vent jet into the port side of the carburetor and tighten it securely.

2- Turn the carburetor upside down. Slide the rubber seal onto the throttle shaft with the lip **TOWARD** the carburetor. **OBSERVE** there are two sizes of springs to be installed onto the throttle shaft of the carburetors. **ALWAYS** install the strongest spring, the one with the largest diameter wire, onto the top mounted carburetor on **ALL** model engines. Slide the flat washer and throttle return spring onto the shaft. Hold the shutter plate in the closed position, and attach the throttle return spring.



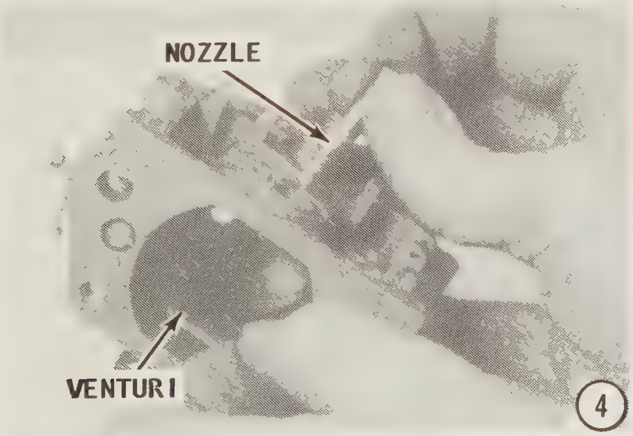


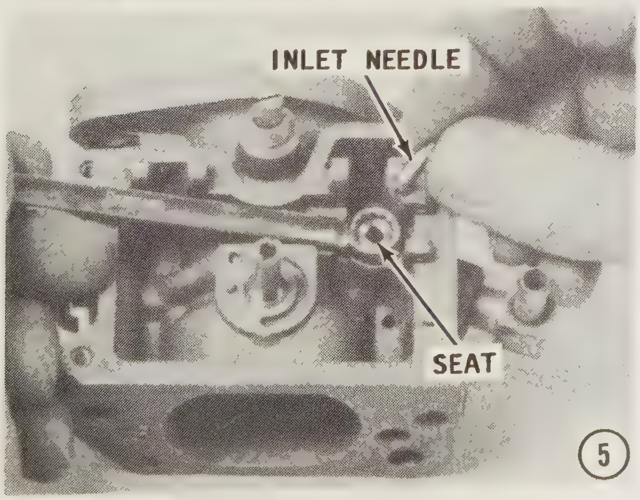


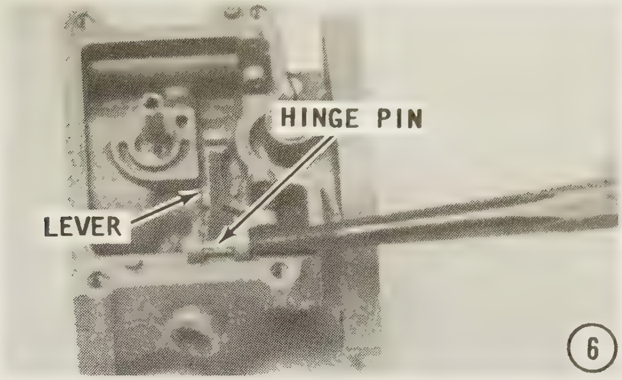
3- Insert the venturi into the front of the carburetor and into the bore. The rounded edge must be installed into the carburetor towards the rear of the carburetor.

4- Install the nozzle through the top of the carburetor and into the venturi. The venturi is now held in place by the nozzle. Tighten the nozzle securely.

5- Position a **NEW** metal gasket onto the carburetor body at the inlet needle seat hole. Install the inlet needle seat, with rubber insert, into place and tighten the seat securely. Slide the needle into the seat.



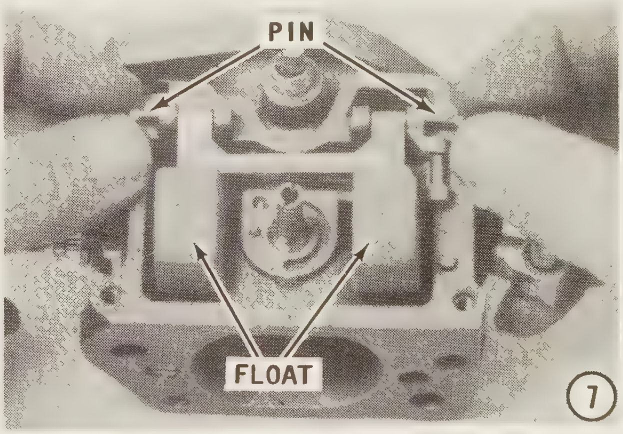


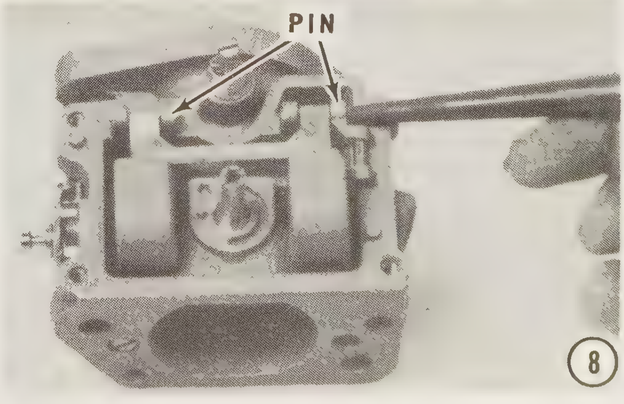


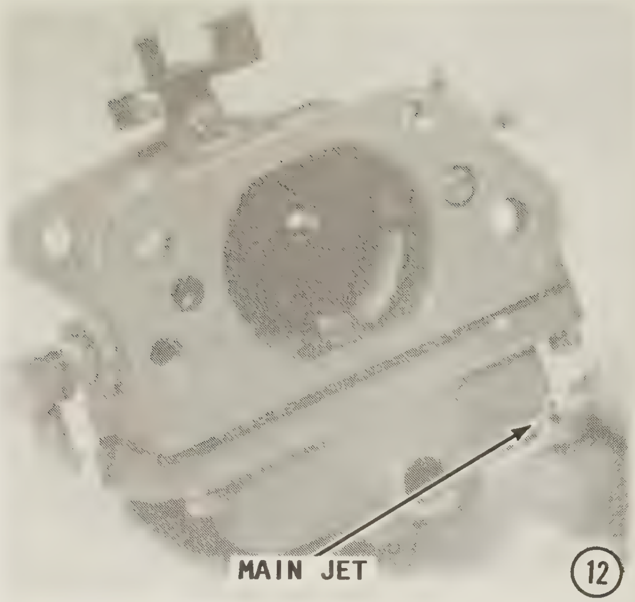
6- Position the float lever between the posts of the carburetor, and then slide the hinge pin into place from the rear of the carburetor. Use a flat end punch and seat the hinge pin until the knurled end of the pin is flush or within 1/32" (0.80mm) from the side of the post.

7- Slide the float into place between the posts of the carburetor. Insert both hinge pins through the posts from the outside edge.

8- Use a flat end punch to push the pins into the posts until the knurled end of each pin is flush or with 1/32" (0.80mm) from the side of the post. Some models of this carburetor may have a single float pin. Installation procedures are identical to those with two pins.







Float Level Bench Adjustment

9- Turn the carburetor upside down with the floats resting on the inlet needle. Measure the distance from the base of the carburetor to the bottom edge of the float. This measured distance must be 11/16" (17.46mm). **CAREFULLY** bend the float lever to obtain the correct measurement.

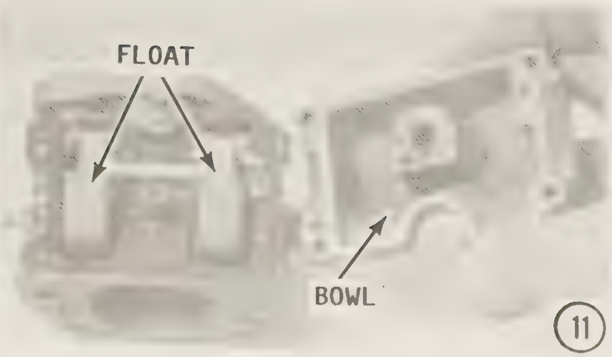
10- With the carburetor still upside down, position a **NEW** gasket onto the body.

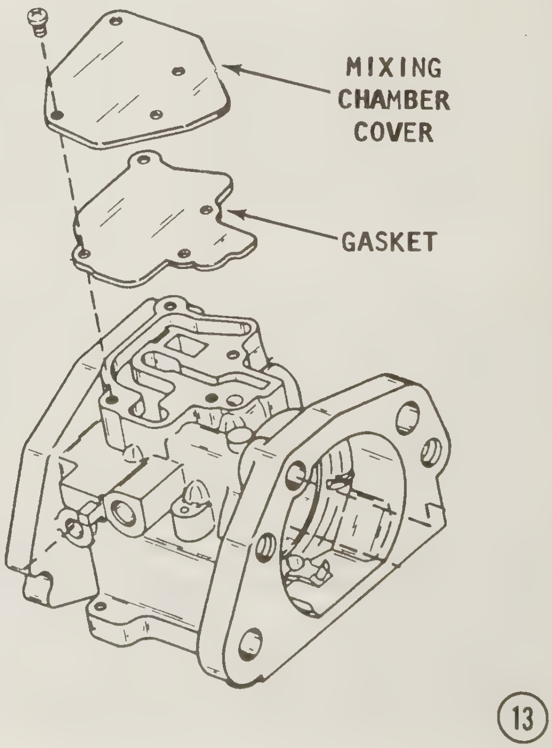
11- Place the fuel bowl in position and secure it with the four attaching screws.

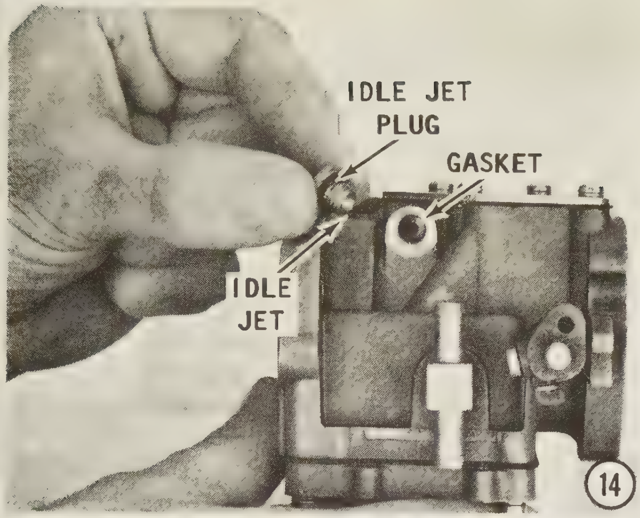
12- Install the main jet into the plug, if it was removed. Use a **NEW** gasket and install the plug into the carburetor bowl.

13- Position the gasket over the mixing chamber. Install the cover and secure it in place with the attaching hardware.

14- Install the idle jet and jet plug with a **NEW** gasket.

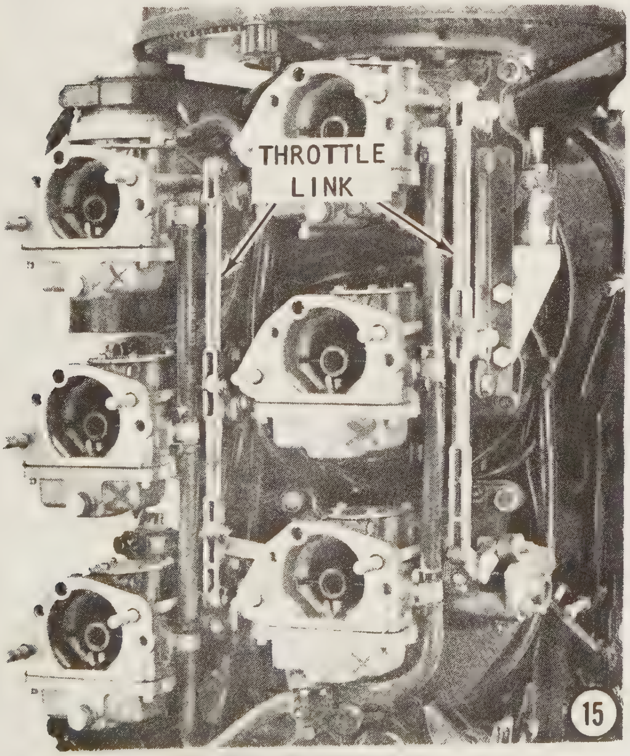






15- Position a **NEW** gasket in place on the intake manifold. Install the carburetor onto the manifold in the same position from which it was removed. Each carburetor should have been identified as instructed during the removal procedures. Secure the carburetor in place with the retaining nuts. Tighten the nuts alternately to the torque value given in the Appendix.

Assemble and install the other carburetors in a similar manner. Connect all fuel and enrichener system lines to the carburetors. Secure the fuel hoses with Sta-Straps. Connect the enrichener valve hose to the fitting on top port side carburetor. Connect the fuel line from the fuel tank.



Activate the fuel line squeeze bulb several times and check the carburetors and fuel lines for leaks. Connect the throttle linkage to and between the carburetors.

16- Place the six air box gaskets over the studs of the carburetors. Install the air box plate with the six locknuts and flat washers per each carburetor bank. Tighten the locknuts to 60 in lbs. (6.8 Nm).

Install the cover over the air box and secure it in place with the attaching screws. Tighten the screw alternately and evenly to 60 in lbs. (6.8 Nm).

Connect the battery leads to the battery.

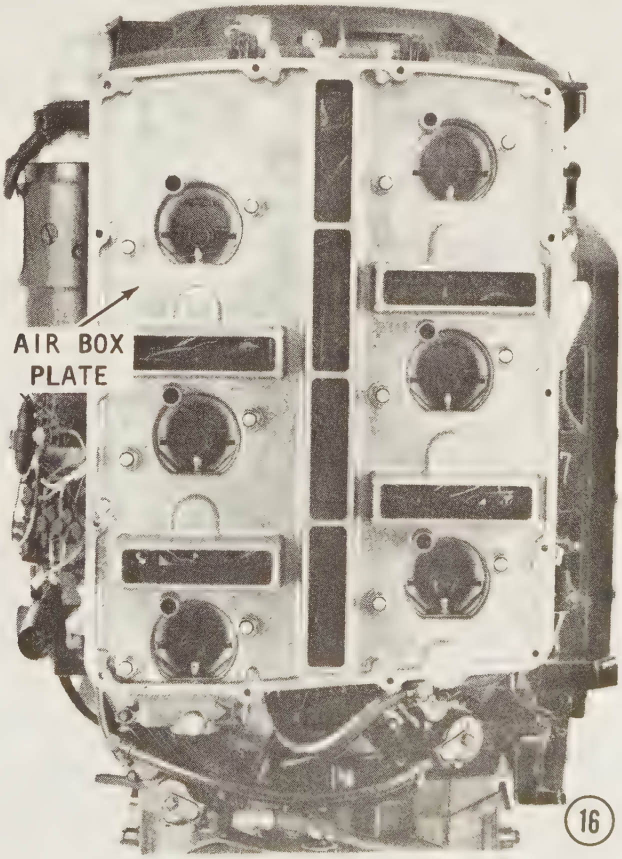
Back the boat into a test tank or adequate body of water.

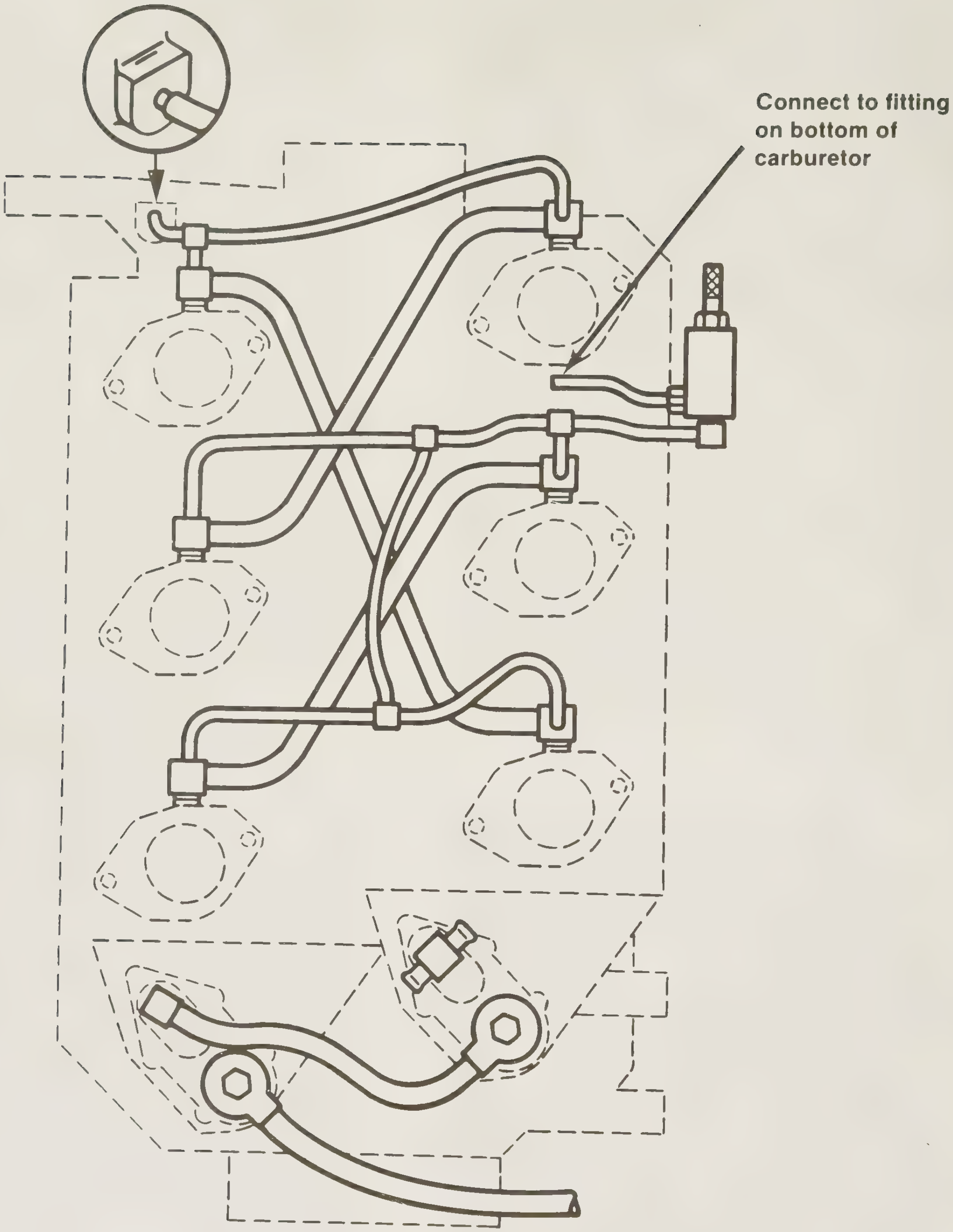
CAUTION: Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Start the engine and check the completed work.

Synchronizing

To synchronize the fuel and ignition systems, see Chapter 6.





Routing of the balance and enrichener hoses for the Model 275hp powerhead with 74° block.

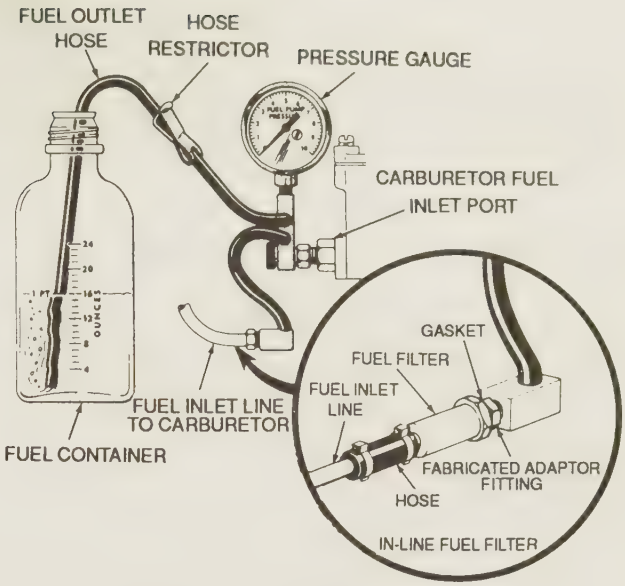
4-8 FUEL PUMP

THEORY OF OPERATION

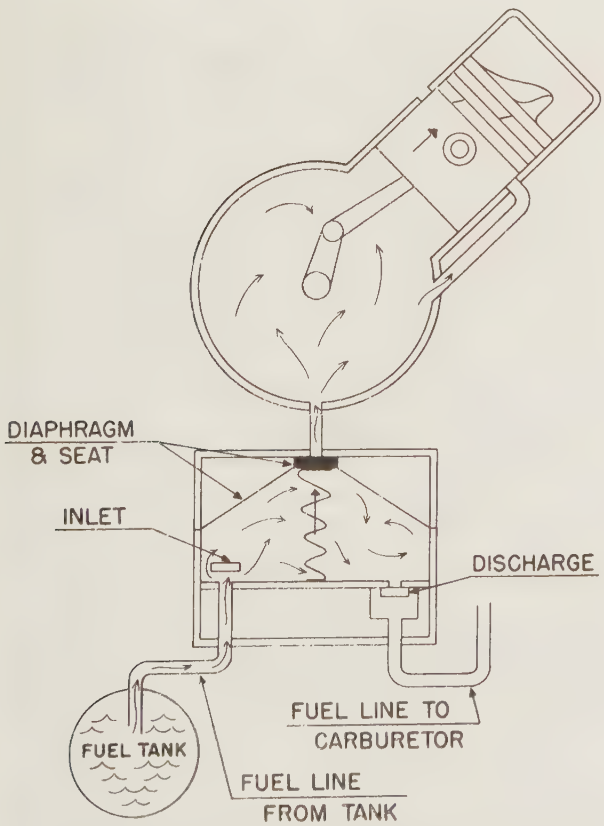
The next few paragraphs briefly describe operation of the fuel pump used on the outboard units covered in this manual. This description is followed by detailed procedures for testing the pressure, testing the volume, removing, and installing the fuel pump.

The fuel pump used is a diaphragm displacement type. The pump is attached to the cylinder bypass. Therefore, it is operated by crankcase impulses. A hand-operated squeeze bulb is installed in the fuel line to fill the fuel pump and carburetor with fuel before the engine starts. After engine start, the pump is able to supply an adequate supply of fuel to the carburetor to meet engine demands under all speeds and conditions.

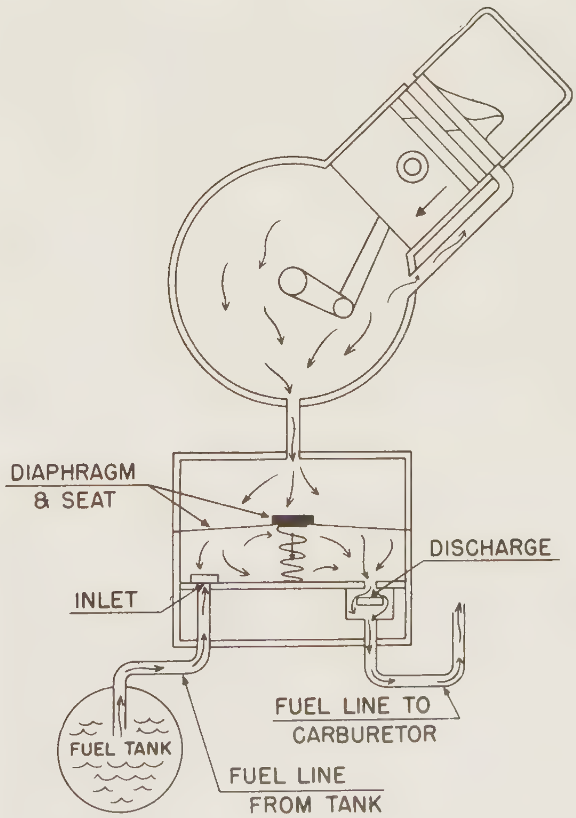
The pump consists of a diaphragm, two similar spring loaded disc valves, one for inlet (suction) and the other for outlet (discharge), and a small opening leading directly into the crankcase bypass. The suction and compression created, as the piston travels up and down in the cylinder, causes the diaphragm to flex.



Test setup to check fuel pump pressure.



Simplified drawing of the fuel pump with the powerhead piston on the upward stroke. Notice the position of the diaphragm; the inlet disc is open; and the discharge disc is closed. The springs to preload the discs are not shown for clarity.



Drawing similar to the one to the left, with the powerhead piston on the downward stroke. Notice the position of the diaphragm; the inlet disc is closed; and the discharge disc is open. Again, the springs to preload the discs are not shown for clarity.

Fuel Filter Test

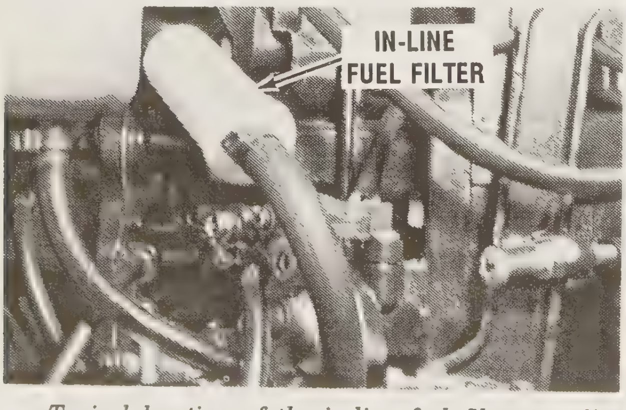
Install a fuel pressure gauge with a "T" in the fuel line between the filter and the top of the No. 1 carburetor. Start and operate the powerhead at WOT and check the pressure reading. The gauge should indicate 3psi.

REMOVAL AND DISASSEMBLING

Turn the fuel shut-off valve to the **OFF** position. Cut away the Sta-Straps from the three hoses at the fuel pump. disconnect the top and bottom fuel lines. Use a golf tee or a stubby pencil to plug the end of each disconnected hose to prevent the loss of fuel. Disconnect the pulse hose from the front surface of the pump. Observe the four bolts. Notice two of the bolts have slotted heads and two are just plain. The two bolts with slotted heads secure the pump to the block. The other two bolts will hold the pump components together while the pump is being removed. Therefore, remove the two slotted bolts and lift the pump clear of the block. Remove and discard the mounting gasket.

Lay the pump on a suitable work surface and remove the two remaining bolts. Now, **CAREFULLY** separate the parts and keep them in **ORDER** as an assist in assembling. Do not remove the check valves unless they are defective. Once removed, the valves **CANNOT** be used again. If the check valves are to be replaced, **TAKE TIME** to **OBSERVE** and **REMEMBER** how each valve faces, because it **MUST** be installed in exactly the same manner, or the pump will not function.

To remove a check valve, grasp the retainer with a pair of needlenose pliers and pull the valve from the valve seat.



Typical location of the in-line fuel filter installed between the fuel pump and the top carburetor.

CLEANING AND INSPECTING FUEL PUMP

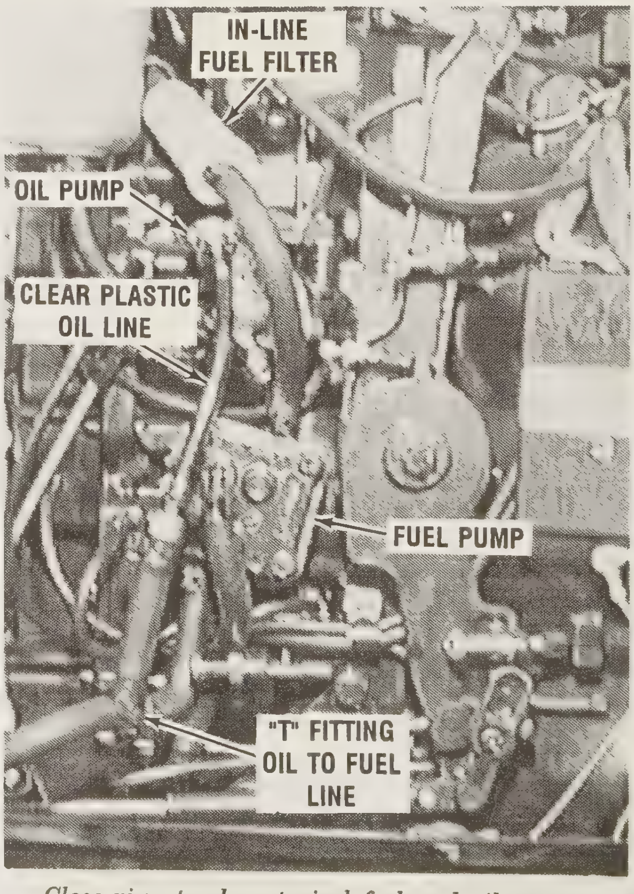
Wash all parts thoroughly in solvent, and then blow them dry with compressed air. **USE CARE** when using compressed air on the check valves. **DO NOT** hold the nozzle too close because the check valve can be damaged from an excessive blast of air.

Inspect each part for wear and damage. Verify that the valve seats provide a flat contact area for the valve disc. Tighten all elbows and check valve connections firmly as they are replaced.

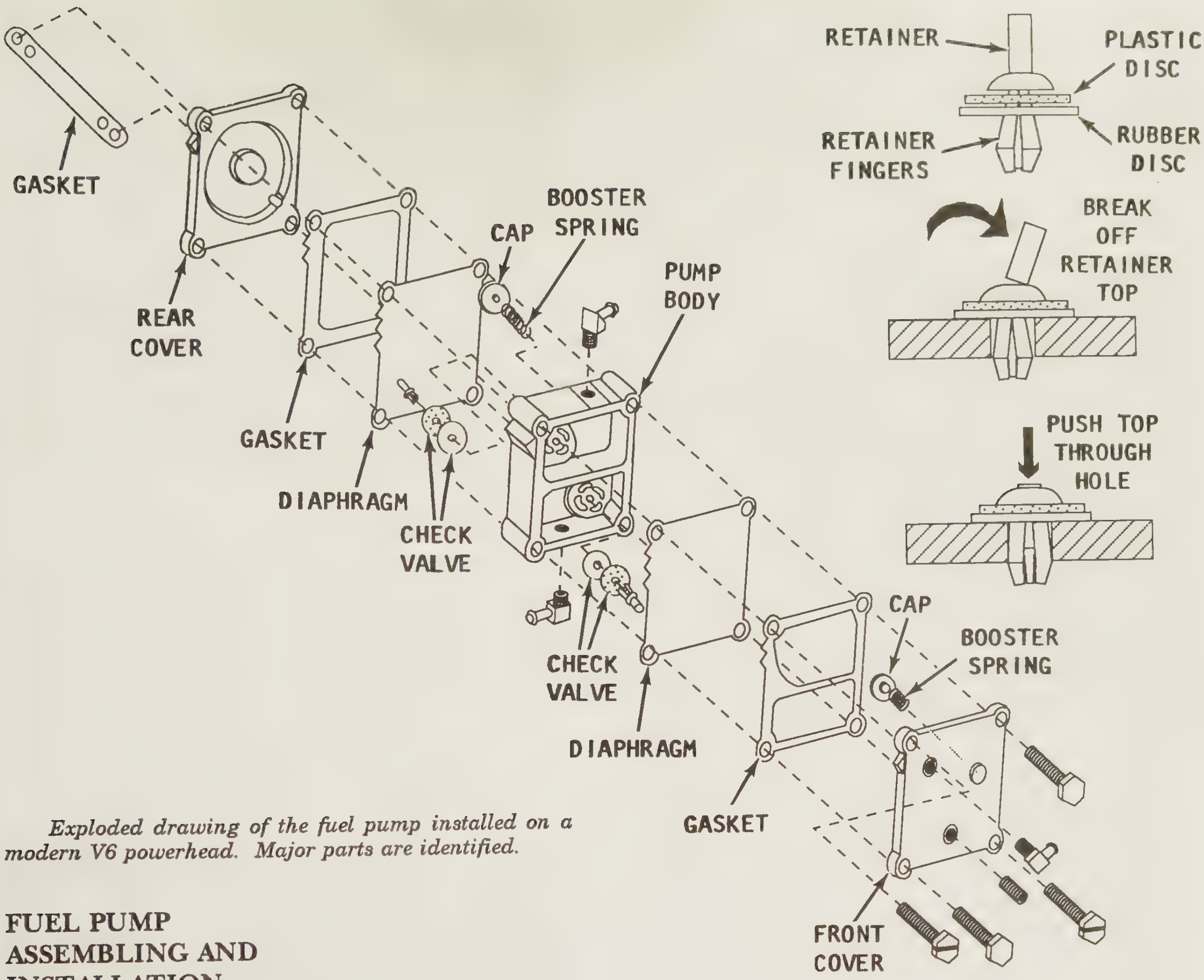
Test each check valve by blowing through it with your mouth. In one direction the valve should allow air to pass through. In the other direction, air should not pass through.

Check the diaphragm for pin holes by holding it up to the light. If pin holes are detected or if the diaphragm is not pliable, it **MUST** be replaced.

If servicing a Model 135hp thru 200hp powerhead -- 1990 and on -- check the condition of the two booster springs.



Close view to show typical fuel and oil component locations on Model 135 thru 225hp powerhead.



Exploded drawing of the fuel pump installed on a modern V6 powerhead. Major parts are identified.

FUEL PUMP ASSEMBLING AND INSTALLATION

The fuel pump rebuild kit will contain new gaskets, diaphragms, and check valve components. Each check valve consists of a large rubber disc, a smaller plastic disc and a valve retainer. Insert the fingers of the retainer into the smaller plastic disc and then the larger rubber disc. Install the two discs and retainer onto the fuel pump body. Push in the retainer until the collar and both discs are tightly pressed against the pump body. Bend the end of the retainer from side to side until it breaks away from the collar. Install the broken off end through the hole in the collar and through the discs. Use a hammer and tap the retainer end down into place. As this piece is forced down, it will spread the fingers of the retainer and secure the check valve within the pump body. Place the larger of the two caps and boost springs into place on the back side of the pump body. All the layered components of the fuel pump have notches which **MUST** be aligned during assembling.

Place a **NEW** diaphragm on the pump body over the large booster spring and cap, followed by a new gasket and the rear cover. Make sure all the notches align.

Position a new diaphragm and gasket over the front of the pump body. Install the smaller booster spring and cap into the front cover. Mate the fuel pump front cover to the body and hold it all together. Secure the pump components together with the two plain head bolts installed in the top right and bottom left bolt holes.

Place the fuel pump on the powerhead base using a new mounting gasket. Install the two retaining screws with slotted heads through the pump and into the engine block. Tighten the screws alternately to a torque value of 50-60 in lb (5.5-6.8Nm).

Connect the fuel lines and turn the fuel valve to the **ON** position.

4-9 ELECTRONIC FUEL INJECTION (EFI)

Some late model V6 powerheads are equipped with an Electronic Fuel Injection (EFI) system. This fuel distribution system is computer controlled. Five different sensors provide the computer with information on rpm, throttle setting, manifold air temperature, powerhead temperature and manifold pressure -which automatically adjusts to barometric pressure. The EFI fuel system includes the fuel tank, an anti-syphon valve, a mechanical fuel pump, an electric "booster" fuel pump, a primary fuel filter, a secondary fuel filter, a vapor separator, a fuel pressure regulator, and an injector fuel rail supporting six fuel injectors. The electronic control system for the fuel system includes the six fuel injectors (each a mini solenoid), five sensors and an Electronic Control Unit (ECU) - a "black box".

GENERAL INFORMATION

Listed below are some of the advantages of a fuel injection system over a carbureted fuel system.

a- More efficient powerhead operation.
b- Thorough atomization of fuel mixture.
c- Increased fuel economy.
d- Fuel efficiency -- complete burning of the injected mixture.
e- Better "volumetric efficiency" -- the ability of the powerhead to breathe air -- due to the absence of a venturi.
f- Less harmful exhaust gases.

The first electronically controlled fuel injection system was introduced over 50 years ago -- in 1932 on diesel truck engines. Today, state-of-the-art microprocessors (commonly referred to as "computer chips") have lowered the cost of electronically controlled fuel injection systems. The price of EFI is now very close to the cost of modern carbureted systems. In the not too distant future, possibly all but the very smallest single cylinder powerheads may be operating with an EFI system.

EFI SYSTEM DESCRIPTION

The type fuel injection used on some late model V6 powerheads such as the Model 200XRi and the Model 175XRi is called "Indirect Multi-Port Fuel Injection", because the fuel is injected into the intake manifold, before entering the combustion chamber.

By design, the method of injection is also termed "Port Tuned Injection" -- each port has minimum and equal restriction to ensure all ports pass the same amount of air into the crankcase.

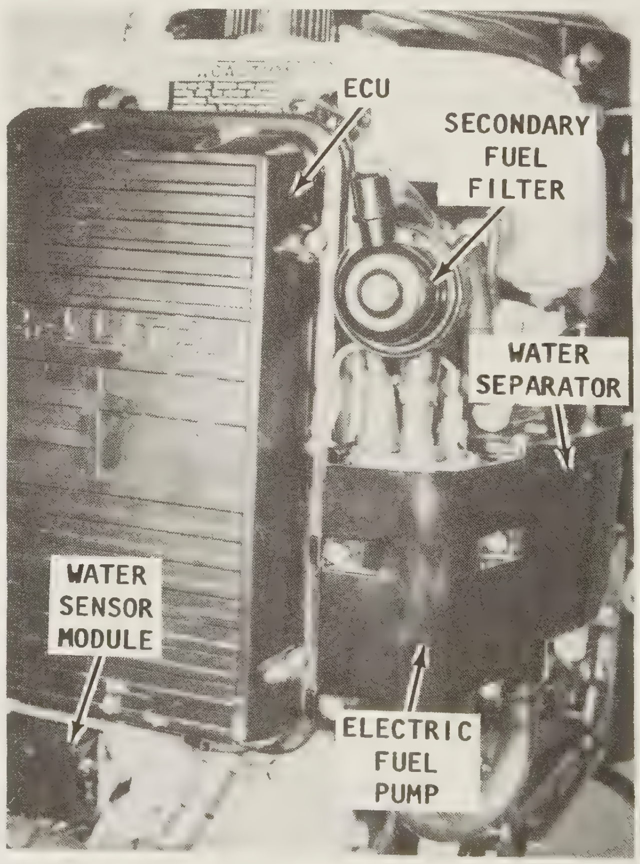
Pairs of injectors are pulsed sequentially and timed to the induction of air into the crankcase.

A computer housed in the Electronic Control Unit (ECU) accepts data from a number of sensors. Based on the information received, the ECU signals each fuel injector to inject a precise and correct amount of fuel.

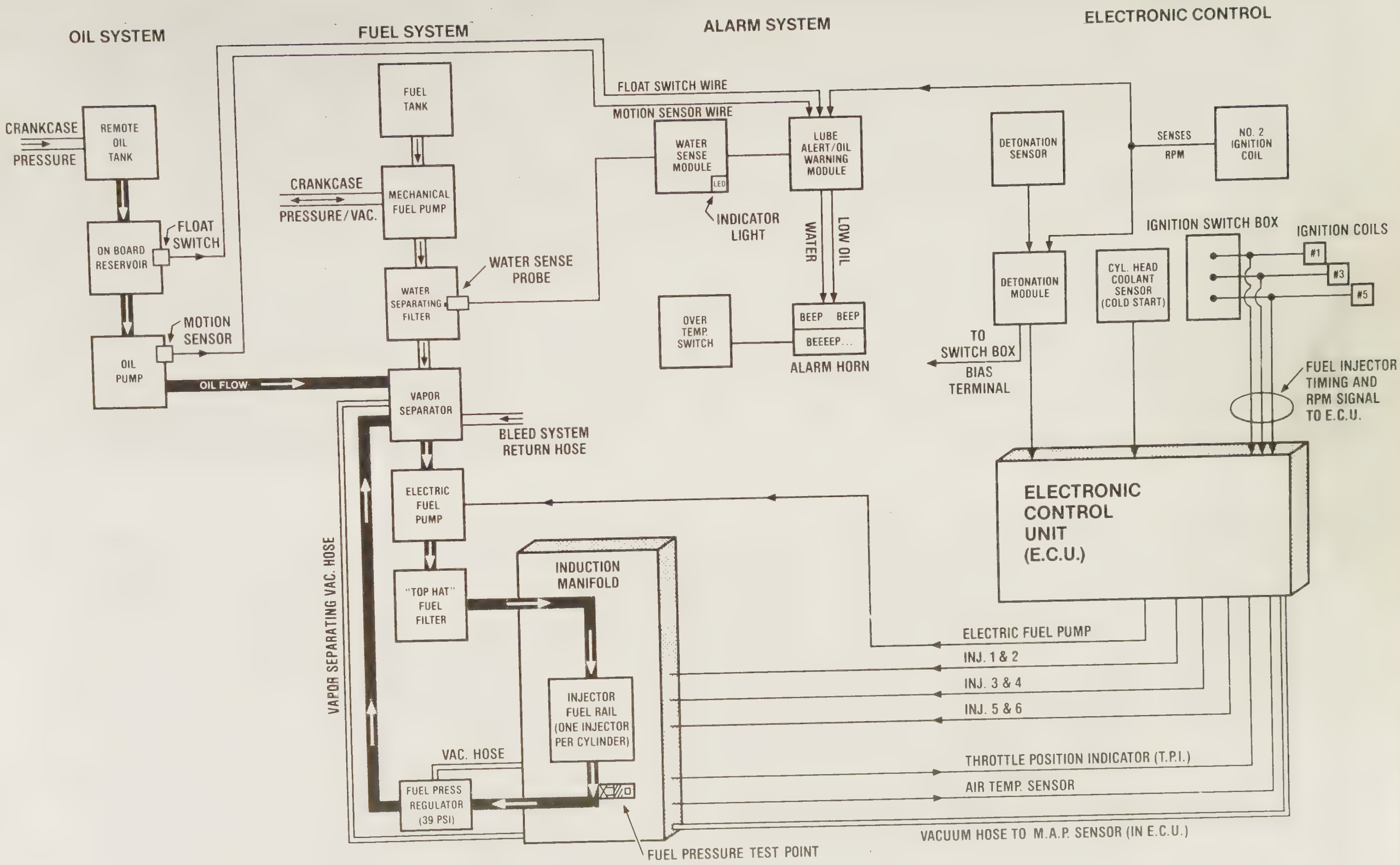
A fuel injection system must provide the correct air/fuel ratio for all powerhead loads, rpm, and temperature conditions.

Manifold Pressure

Under normal operating conditions, an ideal air/fuel ratio is maintained. When the operator places a power demand on the powerhead by advancing the throttle, intake manifold pressure is reduced. Conversely, a reduction in intake manifold pressure, indicates an additional load has been placed on the powerhead. This added powerhead demand requires a richer air/fuel mixture.



Exterior view of a typical EFI system with some of the major parts identified.



Classroom type system schematic to illustrate EFI fuel flow, sensor signal direction, and electrical current.

ECU (Electronic Control Unit)

The ECU computes the new ideal air/-fuel ratio and the fuel injectors deliver the correct amount of fuel. When the powerhead and load demands stabilize, the ECU again receives data from the sensors and re-adjusts the ratio to the new stabilized condition.

Fuel Pumps & Routing

A mechanical fuel pump draws fuel from the fuel tank. Fuel from the tank passes through the primary fuel filter, a water separating filter, and then a vapor separator. An electric fuel pump boosts the flow of fuel from the vacuum operated mechanical fuel pump and passes the fuel on to a secondary fuel filter. A fuel pressure regulator restricts fuel pressure from 36 to 39psi, as set at the factory. Fuel is passed on to the fuel rail and is distributed to each injector. Excess fuel is routed back to the vapor separator.

Air Temperature Sensor

An air temperature sensor is located on the starboard side of the intake manifold, the sensor is mounted under the upper trim/tilt solenoid. Two Brown leads connect the sensor to the ECU. The sensor measures the ambient air temperature and conducts this information in the form of an electrical signal to the ECU. As the air temperature changes, the amount of oxygen per cubic foot also changes. The quantity of available oxygen has an affect on combustion and therefore must be taken into account when computing the ideal air/fuel ratio.

Manifold Absolute Pressure (MAP) Sensor

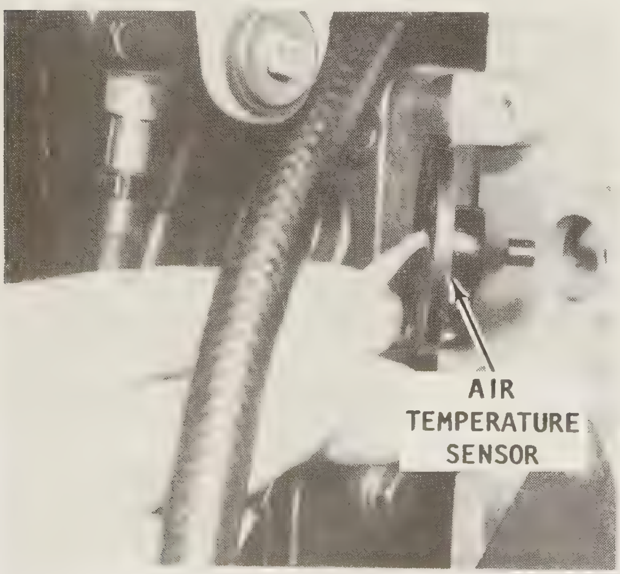
A MAP sensor is located inside the ECU. A vacuum hose connects the intake manifold to the sensor. The MAP sensor is a flexible type resistor. As the pressure changes, the resistor flexes and its resistance and the voltage applied across the sensor changes. This change is registered at the ECU.

Two conditions can affect the pressure in the manifold. The first, and most common condition, is a reduction in manifold pressure when load on the powerhead is increased. As mentioned earlier under "Manifold Pressure", when the operator places a power demand on the powerhead by advancing the throttle, intake manifold pressure is reduced. Conversely, a reduction in intake manifold pressure, indicates an additional load has been placed on the powerhead.

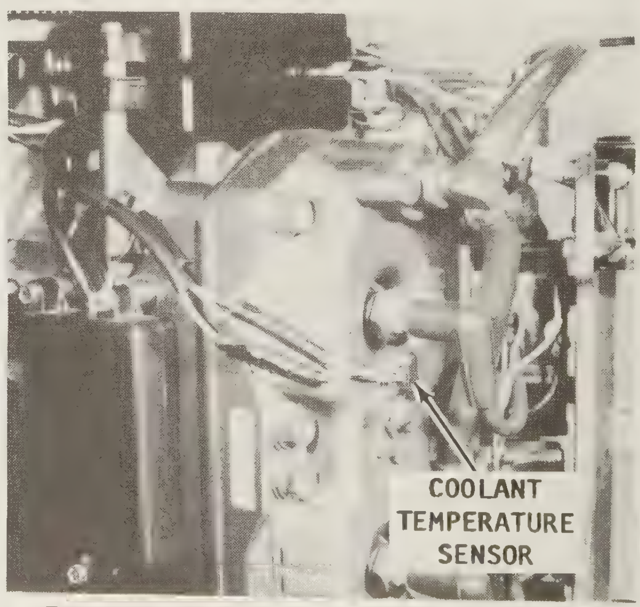
The second condition which may affect the manifold pressure is operation of the powerhead at high altitudes. Would you believe, high barometric pressures, powerhead operation on an extremely hot day, will also affect manifold pressure.

Coolant Temperature Sensor

The coolant temperature sensor is located in the port head. This sensor is a thermistor -- an electronic device which functions in the opposite manner of a resistor.



The EFI air temperature sensor is mounted under the upper trim/tilt solenoid on the starboard side of the powerhead.



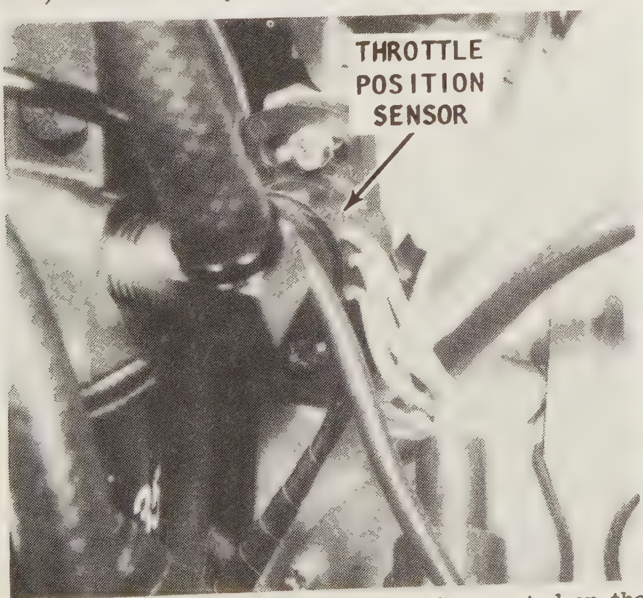
The EFI coolant temperature sensor is located on the port cylinder head.

A resistor increases resistance with temperature (decreases voltage), with an increase in temperature. A thermistor varies resistance (increases or decreases voltage), with a change in temperature. When this voltage is received by the ECU, the information is used to determine injector pulse widths and spark advance. The temperature information is also used to determine if an extra charge of fuel is necessary for a cold powerhead. Powerhead temperature information is used by the ECU to assist in starting a cold powerhead by automatic fuel enrichment. In this manner, a choke is not required. Once the powerhead has reached operating temperature, enrichment is no longer required.

The powerhead temperature sensor has two Tan/Black leads. One lead is routed to the throttle position sensor via a junction and then on to the ECU. The other Tan/-Black lead is routed via a junction to the Orange lead from the throttle position sensor. The Orange lead is then connected to the ECU.

Throttle Position Sensor

The throttle position sensor is mounted on the bottom throttle shaft. The sensor is an encased potentiometer sending a signal to the ECU indicating powerhead load for a specific rpm. Powerhead load is influenced by the load in the boat, by the propeller type and size used with the outboard unit, performance demands imposed by the operator, and other operational factors.



The EFI throttle position sensor is mounted on the starboard side of the powerhead on the bottom throttle shaft.

The body of the sensor is stationary with a small shaft emerging from the center of the sensor. The shaft is connected to the throttle valve. As the throttle is advanced, movement is transferred to the sensor and the resistance changes. Therefore, the variable voltage signal sent to the ECU is directly proportional to the throttle position.

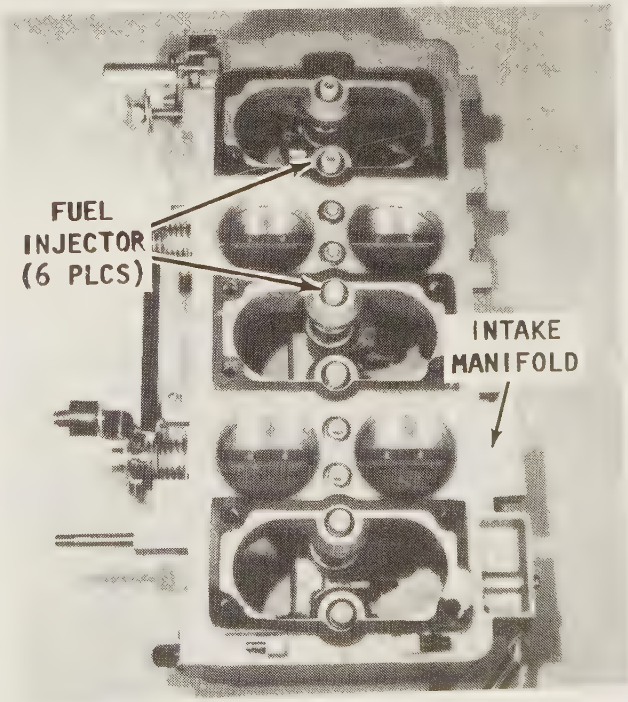
The throttle position sensor has three leads -- a Tan/Black, a Light Blue and an Orange lead. All three leads are connected to the ECU.

Fuel Injectors

The six fuel injectors force fuel under pressure into the intake manifold. Each injector is mounted on the fuel rail.

The injectors used in this type fuel injection system are solenoid operated. Each consists of a valve body, a needle valve, and valve seat. A small voltage is sent from the ECU to each injector. When this voltage is applied to the windings of the solenoid, a magnetic field is induced around the needle valve. The valve lifts off its seat and fuel is allowed to pass between the needle valve and the needle seat. Because the fuel is pressurized, a spray emerges from the injector nozzle.

The time interval for the injector to be open and emitting fuel is called the "pulse width". The actual "pulse width" for the



Intake manifold removed from the powerhead to show location of the six fuel injectors.

injector is controlled by the ECU and must be measured in **MICROSECONDS.**

A small return spring seats the needle valve back onto the seat, the instant the voltage is removed.

The nozzle spray angle of each injector remains constant and is the same for all six injectors.

Two O-rings are used to secure each injector in the fuel rail. One O-ring provides a seal between the injector nozzle and the intake manifold. The other O-ring provides a seal between the injector and the fuel inlet connection. Both O-rings prevent excessive injector vibration. These O-rings are replaceable and are included in an injector overhaul kit.

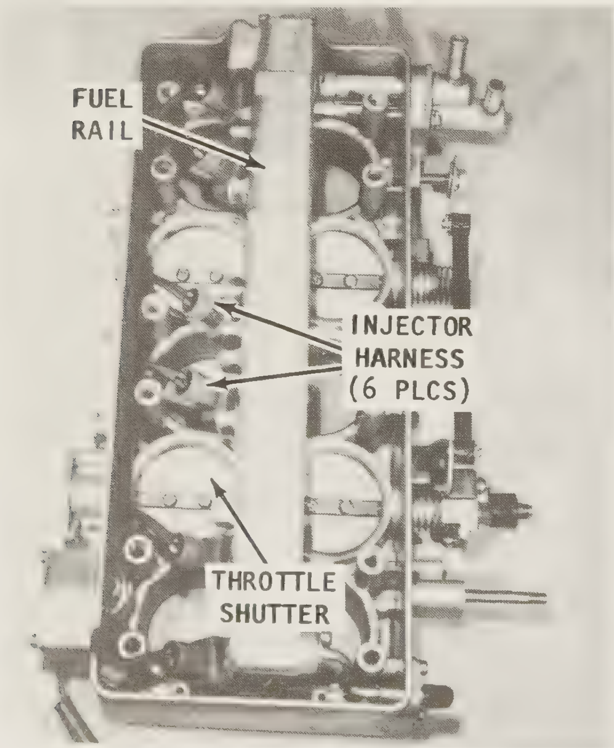
Fuel Rail

The fuel injectors are mounted on a rail extending the length of the intake manifold. Fuel enters the rail at one end and a fuel pressure test point is provided at the other end for troubleshooting purposes. Fuel is evenly distributed from the rail to each injector. The injectors are held in place with fragile wire clips.

Fuel Pressure Regulator

A fuel pressure regulator is connected to the fuel rail. The pressure regulator is a mechanical device used to maintain constant fuel pressure to ensure a uniform spray from the injectors. An electric fuel pump delivers fuel under pressure to the fuel rail. Usually an excessive amount of fuel is delivered to the injectors. All the fuel passes through the injector, but the excess is returned via the fuel regulator assembly in the following manner.

The fuel regulator is pre-set at the factory to operate between 36 and 39psi. When fuel pressure exceeds the regulator setting, excess fuel pushes a spring loaded diaphragm downward. This action uncovers a fuel return port and the excess fuel is routed back to the vapor separator. As the fuel pressure drops, the spring loaded diaphragm relaxes and the fuel return port is closed.



Intake manifold turned over to show the fuel rail injector harness leads and the throttle shutters.

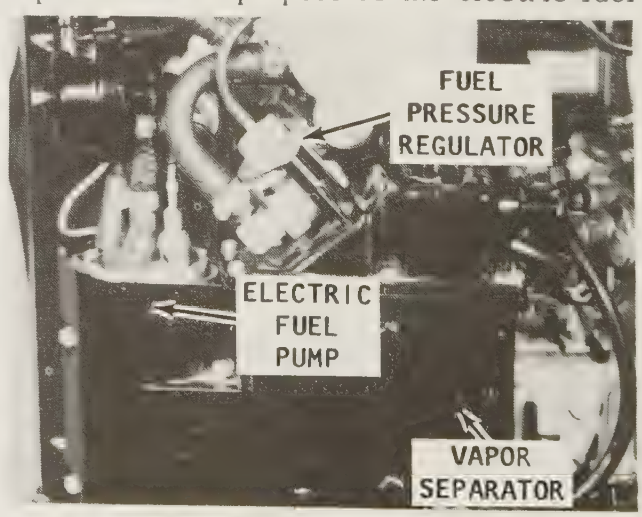
Throttle Shutter

The throttle shutter is a valve mounted at the air intake port of each cylinder. This valve controls the amount of air entering the intake manifold. The valve is controlled by the operator at the remote control box. There are six such valves, one per cylinder and each valve opens simultaneously and equally. The throttle position sensor is mounted on the bottom throttle shaft of the shutter valve.

The throttle position sensor reports the movement of the throttle shutter valve as an electronic signal to the ECU.

Electric High Pressure (Booster) Fuel Pump

The electric fuel pump is mounted on the port side of the powerhead next to the vapor separator. The purpose of the electric fuel



Location of the EFI fuel pressure regulator, electric fuel pump, and the vapor separator.

pump is to boost the initial fuel pressure from the crankcase vacuum operated fuel pump, and deliver the fuel to the injectors under constant pressure of 36 to 39psi.

The electric (booster) fuel pump is a roller-cell type and is **NOT SERVICEABLE.**

The accompanying illustration shows the internal parts of an electric fuel pump. **DO NOT ATTEMPT TO OPEN THE PUMP ON THE POWERHEAD BEING SERVICED.**

Once opened, the airtight seal is lost and the integrity of the seal **CANNOT** be regained. The pump **MUST** be replaced.

This booster pump is unique because the pump and electric motor are housed together in one permanently sealed case, constantly surrounded with fuel. **Yes!**, the fuel actually flows past the electric motor brushes. If the case remains **ABSOLUTELY** airtight, there is **NO DANGER OF EXPLOSION.** However, if the case develops a crack, or is deformed in any way, there is the distinct possibility air may enter the case and together with the fuel form an **EXPLOSIVE MIXTURE!** Fuel, by itself will not ignite while exposed to a spark from the electric motor brushes, because there is no oxygen present for combustion. A mixture

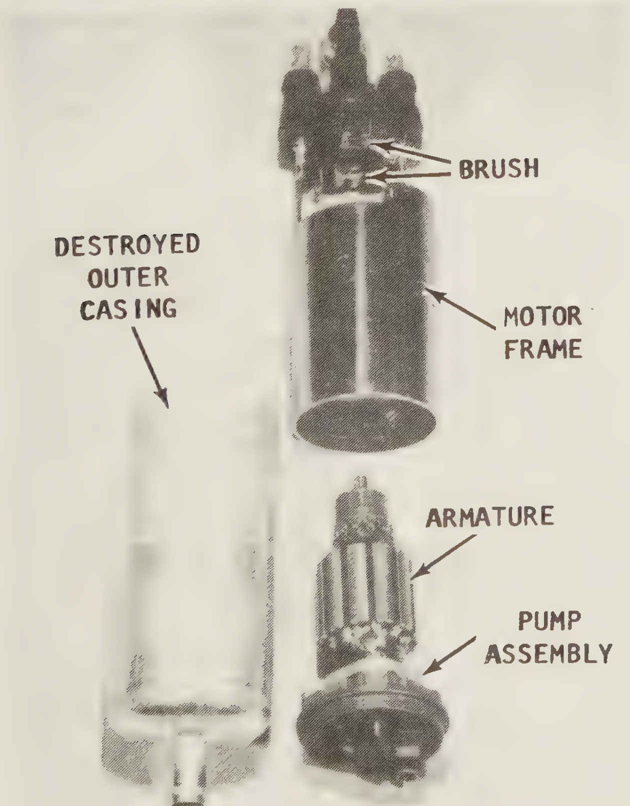


*Illustration to show a destroyed fuel pump. An operational pump is an air tight sealed unit and must **NEVER** be opened. Air inside the pump would create a highly volatile (explosive) atmosphere inside the pump, as explained in the text.*

of 0.7 parts air to 1.3 parts fuel becomes explosive.

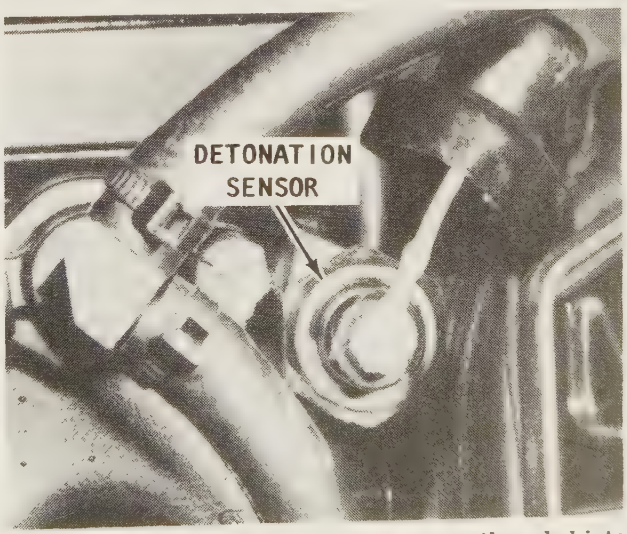
Pump action will commence the moment the ignition key switch is rotated to the **ON** position. If the key switch is held in the **ON** position for more than 30 continuous seconds, the ECU will cutoff electrical power to the pump and of course the pumping action will cease.

CRITICAL SAFETY WORDS

The powerhead must never be cranked without an adequate supply of fuel to the booster pump. If the electric pump draws air into the pump case, an explosive mixture may then form. On the other hand, a fuel injection system cannot be flooded. The fuel pressure regulator will activate the return circuit, and excess fuel will not flood the crankcase, as in a conventional carbureted powerhead. As explained earlier, the excess fuel will be returned to the vapor separator.

Detonation Sensor and Detonation Module

A detonation sensor is threaded into the portside cylinder head. The sensor has a single White/Blue lead connected to the center terminal. This lead connects the sensor to a detonation module which in turn is connected to the ECU. The sensor is able to detect the frequency of vibrations associated with pre-ignition and detonation, approximately 8,000 Hertz. If either of these conditions is due to fuel of an insufficient octane rating (less than 87), or a sudden change in loading of the powerhead, the sensor will be activated.



Location of the EFI detonation sensor threaded into the port cylinder head.

An electronic signal is sent to the detonation module and the ECU. The result of these signals is ignition timing being retarded by as much as 8^{o}.

Water Presence Sensor and Water Separating Filter

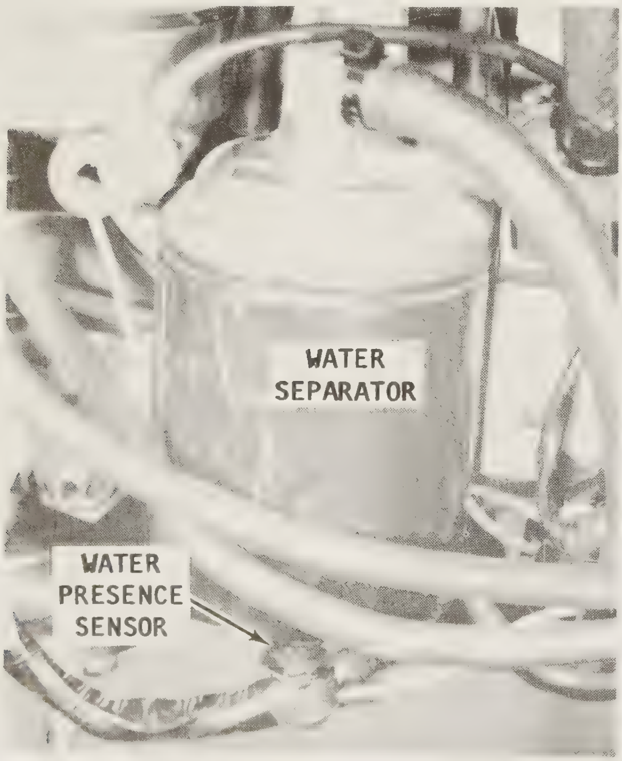
A canister type filter is installed between the mechanical fuel pump and the vapor separator. The purpose of this filter is as the name suggests, to separate water from the fuel. The presence of water in the fuel will alter the proportion of air/fuel mixture to the "lean" side, resulting in a higher powerhead operating temperature and possible damage to pistons if not corrected.

A water presence sensor is located at the base of the water separating filter. A Tan lead connects the sensor to a water sensor warning module, with an LED indicator warning light to inform the operator of an unacceptable quantity/level of water in the fuel. A signal is also transmitted to the Lube Alert Oil Warning Module which houses a horn, sounded at the signal of excess water in the filter.

RPM Sensor

The powerhead rpm sensor is housed within the ECU. Electronic pulses from the No. 2 ignition coil through the detonation module are received by the rpm sensor. These signals indicate powerhead rpm.

A Green lead connects the No. 2 ignition coil to the detonation module and then by a different colored lead to the ECU.



The EFI water separator is a disposable canister type filter with a sensor mounted on the filter base.

Vapor Separator

The vapor separator is located between the water separating filter and the electric fuel pump on the portside of the powerhead. This separator eliminates vapors from the fuel before the fuel reaches the electric fuel pump. The presence of vapors in the electric fuel pump could be **MOST HAZARDOUS!**

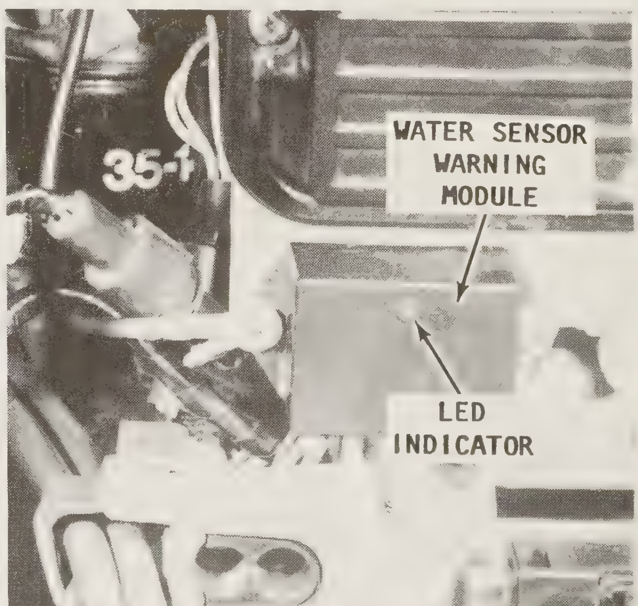
This type separator is called a float type, because it closely resembles a gigantic carburetor float bowl. Fuel and the associated vapors enter the separator from the water separating filter. Fuel in the separator causes the float to rise.

The vapor separator performs three essential functions:

1- Fuel vapors are channeled to the intake manifold and only liquid fuel is permitted to enter the electric fuel pump.

2- The vapor separator provides the means for mixing liquid fuel and oil from the oil pump.

3- The separator accepts excess fuel recycled into the system from the fuel pressure regulator and the powerhead bleed system.



The EFI water sensor warning module is mounted beneath the ECU. The module has an LED indicator light to warn the operator of an unacceptable amount of water in the fuel.

Electronic Control Unit (ECU)

The fuel injection system is controlled by the ECU -- an onboard computer mounted as far from heat and vibration as possible. The computer is a sealed "black box" type unit and is in no way serviceable. The ECU receives signals from numerous sensors on the powerhead. From the signals received, the ECU determines the amount of fuel to be injected. This computer also determines the timing of the spark at the spark plugs.

The amount of fuel injected is determined by how long each injector nozzle remains open -- the "pulse width". The nozzle opens and closes in response to signals from the ECU.

The ECU receives three types of imput signals.

Analog signals change with changing conditions. For example: the coolant temperature sensor will have more electrical resistance when the powerhead is cold, than when the powerhead is hot.

Digital signals are a series of on and off pulses. These pulses are counted by the computer to determine a condition. For example: the signal sent from the No. 2 ignition coil will provide the computer with information on powerhead rpm.

Pressure Differential signals received through vacuum lines connecting the intake manifold to the ECU indicate powerhead loading to sensors within the computer.

Sensors located on the powerhead or inside the "Black Box" provide information to the computer on powerhead load, rpm, temperature and other conditions affecting operation.

The computer is **programmed** or provided with instructions, to produce correct air/-fuel mixtures and throttle openings for varying conditions.

Primary Fuel Filters

A fuel filter is installed at the base of the pickup tube in the fuel tank. Another fuel filter is installed at the inlet fitting of the crankcase vacuum operated fuel pump. In some cases, an in-line filter is installed between the fuel tank and the primary pump.

Secondary Fuel Filter

The secondary fuel filter, sometimes referred to as a "Top Hat" filter, is a very fine mesh screen filter mounted above the electric "booster" fuel pump. This filter performs the final filtering function before fuel enters the fuel rail.

Anti-Syphon Valve

An anti-syphon valve is considered an "After Market" item, not installed by the factory. Many people consider such a device to be a safety item, but more often than not, they cause more problems in the fuel delivery system than they solve.

If the valve becomes the least bit clogged with debris or a too small valve is installed in the fuel line, or the spring is too stout, a pressure drop may develop from one side of the valve to the other. A pressure drop across the anti-syphon valve can cause poor powerhead performance and possible damage.

A defective or poor operating anti-syphon valve may cause one or more of the following problems:

Inadequate fuel pump pressure.

Loss of power at the powerhead.

Powerhead surging at high speed rpm.

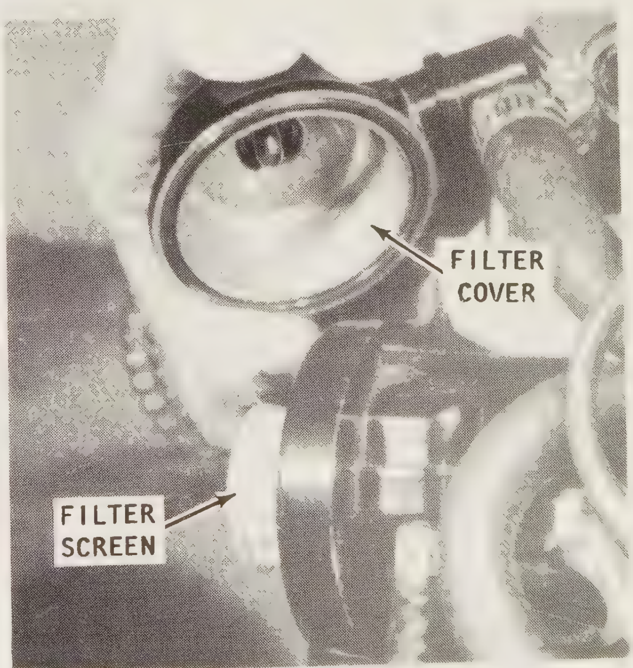
Piston dome erosion due to preignition or detonation.

Poor powerhead performance during acceleration -- unit falters or cuts out completely.

Powerhead fails to operate smoothly -- runs "rough".

Powerhead shuts down and fails to start.

Powerhead cannot be started.



*The EFI system **MUST** be depressurized before the filter cover is removed, as explained in the text.*

TROUBLESHOOTING EFI

If a problem is encountered with powerhead startup or operation, the determination must be made: the problem is in the ignition system or the fuel system is at fault.

The first and easiest test to determine an ignition problem is to perform a spark test as outlined in Chapter 5. If the ignition system checks out and the preliminary troubleshooting narrows the area to the fuel system, proceed with the following fuel system tests.

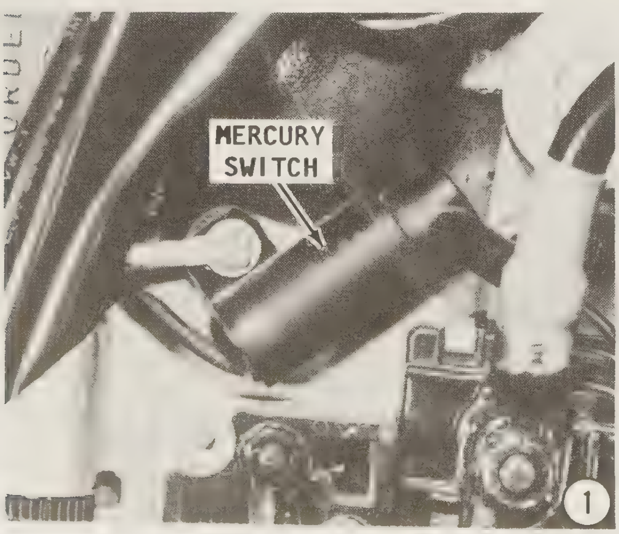
Checking Anti-Syphon Valve

If troubleshooting should indicate the anti-syphon valve is at fault, attempt to operate the powerhead with a separate source of fuel. In other words, the valve is physically bypassed.

If the valve proves to be the source of the problem, either remove the valve from the fuel line or replace the valve with a solenoid operated fuel shutoff valve.

VERY IMPORTANT WORDS

The following tests were designed for the person working with a Volt/Ohm/Ammeter only. All dealerships will have a Quicksilver Fuel Injection Tester. Seloc strongly suggests a certified marine mechanic be contacted to check a suspected EFI electrical component. The part may be removed and bench tested in the shop or left installed on the powerhead and tested in a shop having the professional test equipment. Proper testing and accurate diagnosis is **CRITICAL** before purchasing an expensive **NON-RETURNABLE** electronic component, especially a **NEW** ECU.



Installed Injector Test

1- Connect one end of a jumper cable to the terminal of the mercury switch and the other end to a suitable ground on the powerhead. The terminal will have a Black/-Yellow lead attached to it. Grounding the mercury switch is necessary to prevent the powerhead from accidentally starting while tests are being performed. Keep switch grounded with the jumper cable in place while performing Steps 2 thru 12, then remove the cable.

2- Rotate the ignition key to the **START** position and crank the powerhead through several revolutions. Rotate the key switch back to the **OFF** position. Remove the spark plugs one by one and inspect the electrode end. A damp electrode will indicate the injector is functioning for the cylinder being checked.

If all spark plugs are damp indicating the presence of fuel, all injectors are spraying fuel into the crankcase. If some spark plugs are damp with fuel, while others are dry, the electric fuel pump is probably functioning correctly. However, either the injectors of the "dry" cylinders have a restricted fuel flow **OR** the dry injectors have an electrical problem.

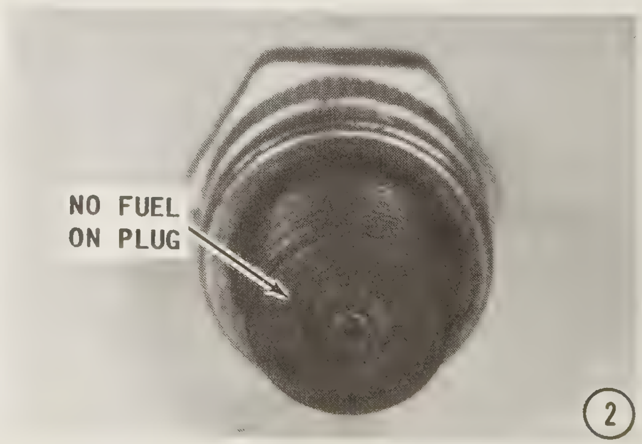
If all spark plugs are dry -- none are damp with fuel, a problem with fuel delivery exists. The problem may be:

A main fuel line blockage.

A faulty electrical component affecting operation of the entire system, such as a defective electric fuel pump, defective injector harness plug, or a component within the ECU.

Voltage to Electric Fuel Pump Test

3- Leave one end of the jumper cable connected to a good ground on the powerhead. Disconnect the other end of the cable



from the mercury switch. This connection was made in Step 1. Now, connect free end of the jumper cable to the negative terminal on the electric fuel pump -- the terminal with a Red/Purple lead still attached.

CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

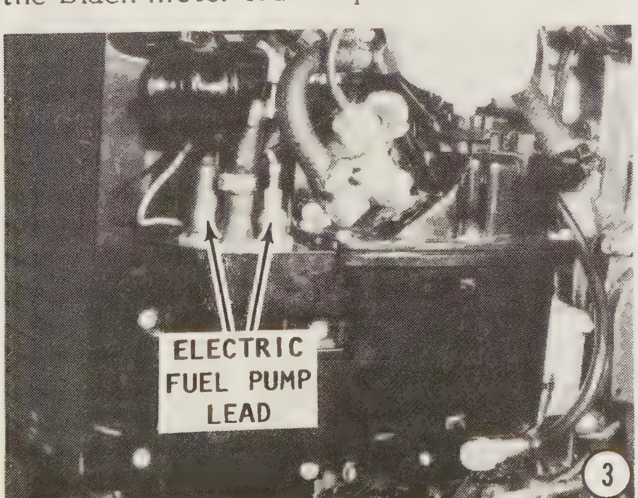
Attempt to start the powerhead. If the electric fuel pump now operates and the powerhead starts, the problem is a bad ground connection to the pump. Unfortunately, the Red/Purple ground lead is connected directly to the ECU. To obtain a satisfactory ground, the temporary jumper cable must be replaced with a new permanent ground lead.

If the powerhead did not start, remove the temporary jumper cable from the electric fuel pump terminal and connect it back to the terminal on the mercury switch, as directed in Step 1.

Obtain a voltmeter. Select the 12V DC scale. Rotate the ignition key to the **ON** position, with the jumper cable connected to the mercury switch still in place.

Disconnect the Red lead at the positive terminal on the electric fuel pump. Make contact with the Red meter lead to the positive terminal on the pump. Make contact with the Black meter lead to a suitable ground on the powerhead. The meter should register 12V.

If the meter fails to register 12V, keep the Black meter lead in place and move the



Red meter lead to the positive terminal on the rectifier.

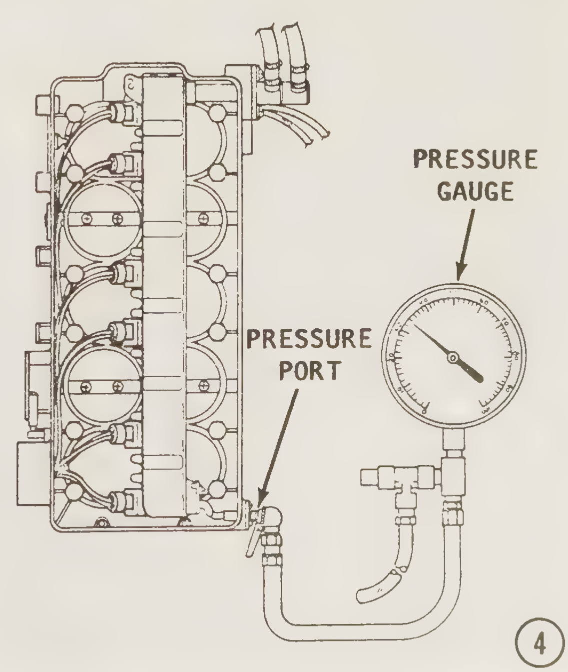
If the meter registers 12V at positive rectifier terminal, the ECU is defective, because the ECU is not transmitting voltage from its pickup point (here at the positive rectifier terminal) and delivering voltage to the pump.

If the meter fails to indicate 12V at the rectifier, the ECU is not being supplied with power and therefore cannot pass it on to the electric fuel pump. In this case the fault may lie in the battery, cables, connections, harness plug, or ignition switch.

If the meter registered 12V at the electric fuel pump, the ECU is functioning correctly and the problem may lie in the portion of the fuel system past this connection: the electric fuel pump, the secondary filter or the injector harness plug.

Testing Electric Fuel Pump Operating Pressure

4- Obtain a pressure gauge capable of registering 50psi. Remove the plastic cap from the pressure port located portside at the bottom of the intake manifold. Connect the gauge to the pressure port. Rotate the ignition key to the **ON** position and crank the powerhead for about 15 seconds, with the jumper cable still in place grounding the mercury switch. Note the reading on the gauge. Normal powerhead operation requires pressure between 36 and 39psi (248.2 to 268.9kPa).



If the reading is low, the cause may be a restriction in a fuel line. If there is no reading, the pump is defective and **MUST** be replaced. The pump is a sealed unit and **CANNOT** be serviced. See Page 4-74 for instructions on pump removal and replacement.

Secondary Fuel Filter

GOOD WORDS

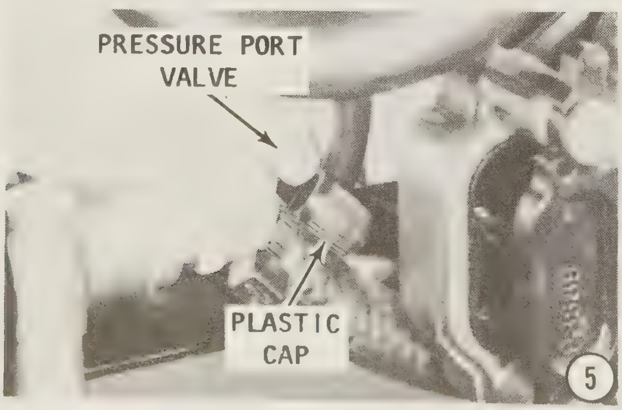
If the previous test proved fuel was being pumped from the electric fuel pump, then a clogged secondary fuel filter may be obstructing fuel flow to the fuel rail and injectors. Before the secondary fuel filter is removed, the system **MUST BE DEPRESSURIZED**, as described in the following step.

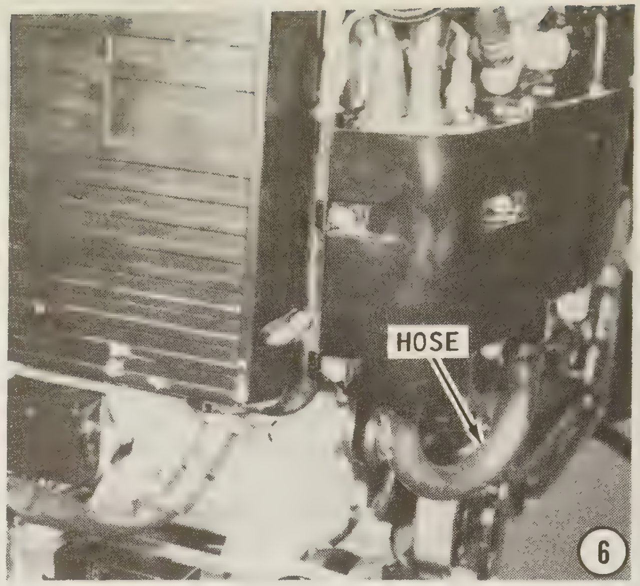
5- Remove the plastic cap over the pressure port located portside at the bottom of the intake manifold. A screwdriver will be used to depress the valve tip to release the pressure and allow fuel to drain from the valve. Place the screwdriver tip lightly over the valve tip and wrap a clean shop towel around the valve and screwdriver. This operation is similar to letting air out of tires! Once all pressure has been released and the fuel flow ceases, refer to Page 4-72 to remove and service the secondary fuel filter.

Fuel Flow to Electric Fuel Pump

6- Obtain a suitable container and place it under the electric fuel pump and the vapor separator. Snip the Sta-Strap around the hose connected to the bottom of the electric fuel pump. Gently pry the hose from the fitting on the pump and place the end in the container.

Rotate the ignition key to the **ON** position and crank the powerhead, with the jumper cable still in place on the mercury switch, for about 15 seconds.



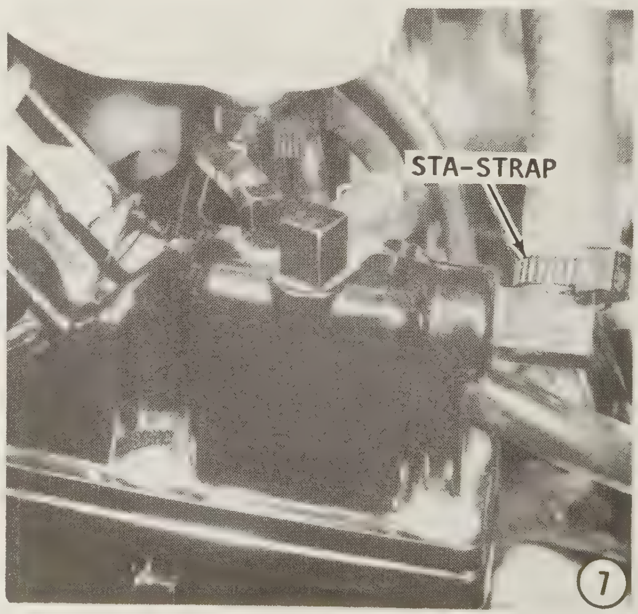


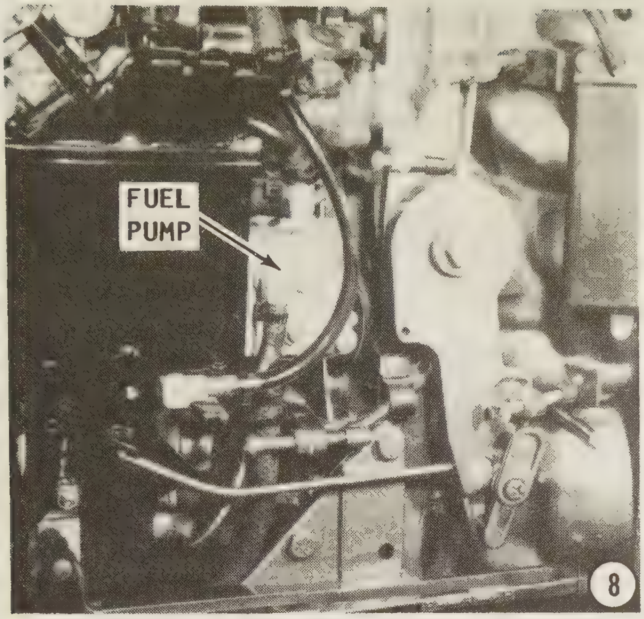
If fuel flowed from the disconnected hose, then all is well with the vapor separator, crankcase vacuum operated fuel pump, and water separating filter. Reconnect the hose using a new Sta-Strap. If no fuel flowed, the problem could be with one of the components just mentioned.

If the vapor separator is suspected, see Page 4-74 for detailed procedures to remove, service and install the separator. After the work has been done, repeat Step 4 to test the separator. If a course of further testing is decided upon, reconnect the hose using a new Sta-Strap.

Fuel Flow Through Water Separating Filter

7- Obtain a suitable container. Snip the Sta-strap around the hose connected to the

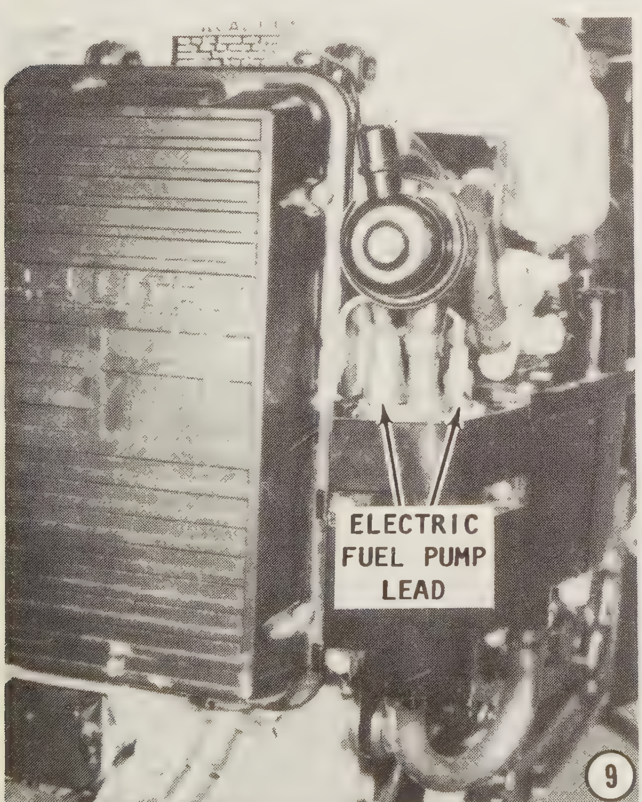




top of the vapor separator. Gently pry the hose from the fitting on the separator and place the end in the container.

Rotate the ignition key to the **ON** position and crank the powerhead, with the jumper cable still in place on the mercury switch, for about 15 seconds.

If fuel flowed from the disconnected hose, then all is well with the crankcase vacuum operated fuel pump and water separating filter. Reconnect the hose using a new Sta-strap.



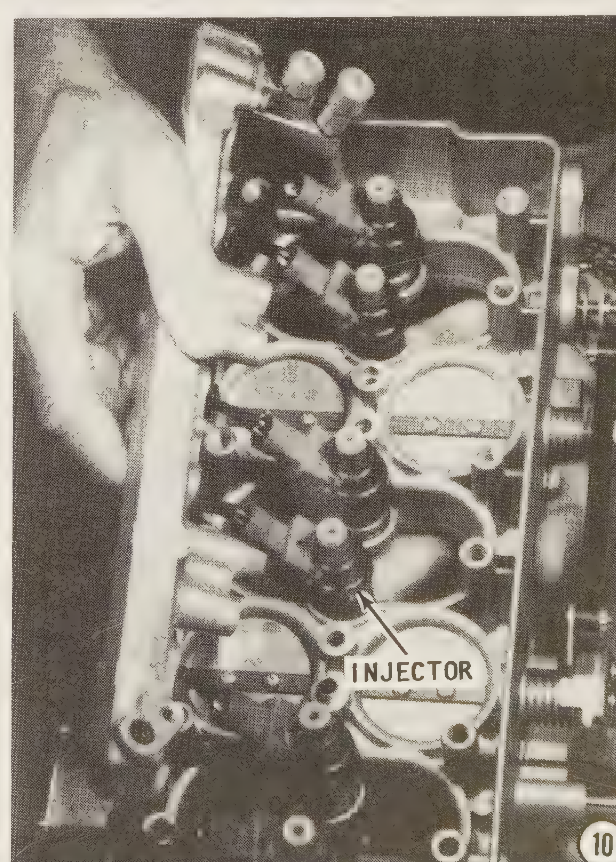
If no fuel flowed, the problem could be with one of the components just mentioned. Continue with the test procedures outlined in the following step to determine if the fuel is reaching the water separating filter. If fuel is found to flow up to the filter, but not through the filter, remove the Tan lead at the filter base. Remove the two fuel lines from the filter. Remove the attaching hardware and the filter. Install a new filter and secure it to the powerhead with the attaching hardware. Connect the two fuel lines and the Tan lead to the filter base.

Testing Crankcase Vacuum Operated Fuel Pump

8- To test the fuel pump, see the procedures beginning on Page 4-9. Service procedures for the fuel pump begin on Page 4-42. If the pump checks out okay, the fault may lie in the in-line fuel filter, or the filter at the base of the fuel tank pickup. Inspect, clean and replace as necessary.

Testing Injector Wiring Harness

9- Disconnect both the Red/Purple and Red leads at the fuel pump, to prevent the fuel being pumped during this test. Position the Red "hot" lead in such a manner to



prevent it from making contact with any part of the powerhead.

10- To test for voltage to the injectors, the injector harness connector plug must be removed from each injector at the fuel rail. Perform Steps 1 thru 19 on Page 4-61 to remove the ECU and the induction cover from the manifold. These steps can be performed with the unit removed from the powerhead, or with the unit still in place on the powerhead. The bolts securing the cover to the powerhead, pass through the nanifold. Therefore, temporarily reattach the manifold to the powerhead while performing this test.

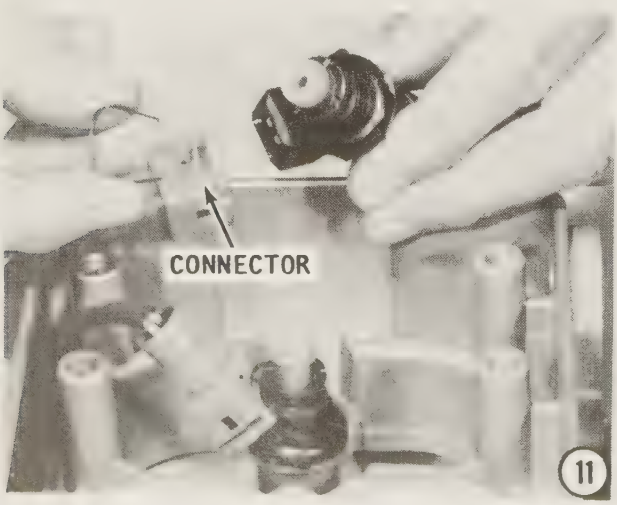
11- Once the connector has been removed from the injector, obtain a voltmeter and set the scale to 12V DC. Obtain a small jumper cable and use it to ground the manifold to the powerhead, because the three original grounding leads were removed in Step 9.

Rotate the ignition key to the **ON** position with the jumper cable still in place on the mercury switch.

Connect the Red meter lead to the Red injector lead and connect the Black meter lead to the other colored lead (two White, two Dark Blue and two Yellow leads) at each injector in turn.

The meter should register at least 9V at each injector. If voltage is present at each injector harness plug, skip the following test and proceed to Step 13. If voltage is not present at **ANY** injector connector plug, but Step 3 proved the ECU is supplied with battery voltage, then the ECU may not be supplying voltage to the main injector wire harness plug.

Reconnect the Red/Purple and Red leads at the electric fuel pump.



12- Disconnect the main injector harness at the connector plug. With the ignition key still in the **ON** position and with the jumper cable still in place on the mercury switch, check for voltage output from the ECU.

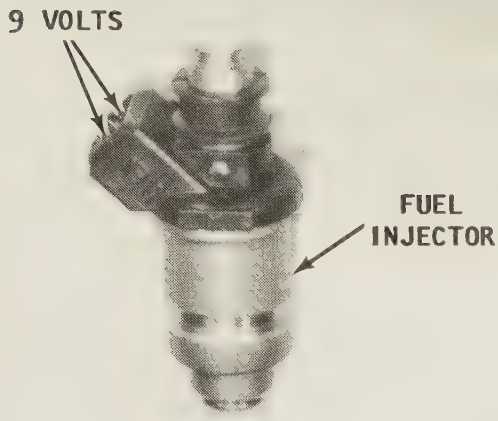
Obtain a voltmeter set to the 12V DC scale. Make contact with the Black meter lead to a good ground on the powerhead. Make contact with the Red meter lead to the Red #6 lead terminal at the connector plug from the ECU. If the meter registers no voltage, verify voltage is being supplied to the ECU by momentarily touching the Red meter lead to the "+" terminal on the rectifier. If voltage is indicated, then either the ECU is defective or there is a problem in the main ECU harness plug (which probably means a new ECU is required). If no voltage is indicated, remove the ECU and take the "Black Box" to the dealer for testing with a Quicksilver Fuel Injection Tester before purchasing a new unit.

If voltage is indicated at the Red #6 lead terminal at the connector plug from the ECU, but no voltage is indicated at any or only some of the plug connectors at the injectors, the injector harness is defective and must be replaced with a new harness.

The jumper cable, temporarily grounding the mercury switch, may now be removed and the Black/Yellow lead reconnected to the mercury switch terminal.

Testing Fuel Injectors

13- Follow the procedures outlined on Page 4-61 to remove the fuel injectors. Once the injectors are unplugged from their wiring harness and removed from the fuel rail, a simple test with a 9V battery can be performed to determine if the solenoid inside the injector is functioning properly.



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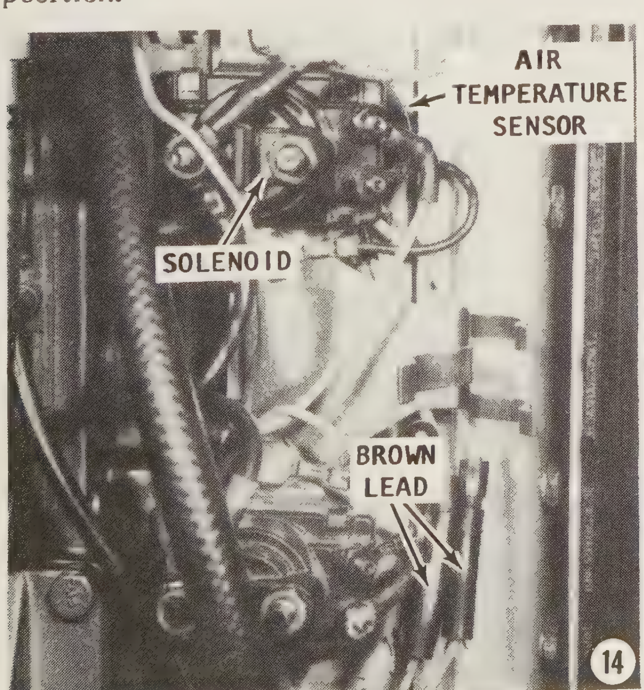
Obtain a 9V battery, such as those used in radios and calculators. Obtain two jumper leads with small alligator clips at each end.

Momentarily connect the battery across the two terminals inside the injector connector, making sure the two leads do not contact each other. For these tests the jumper cables may be connected in either way, because polarity does not affect the tests.

As soon as contact is made, the injector should emit a sound as the solenoid is energized and the needle is pulled off its seat. When contact is broken, the injector should again emit a sound as the needle returns under spring pressure back to its original position.



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Perform this test on each injector in turn. If any injector fails this test, there is an internal defect in the injector. The needle is stuck or there is bad electrical connection. The injector must be replaced. A quick test to determine which of the two listed reasons prevent the injector from working properly is to perform a resistance test across the two injector terminals using a **DIGITAL** ohmmeter set to the Rx1 scale. Ohmmeter leads across the two injector terminals should register a reading of 1.1 ohm.

A clogged injector may possibly be cleaned by purchasing a fuel additive from the local automotive parts supply store and following the directions on the can.

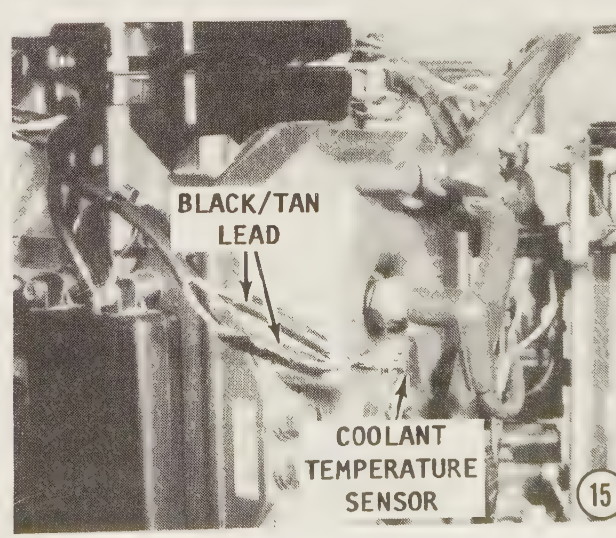
Air Temperature Sensor Resistance Check

The air temperature sensor need not be removed from the powerhead for testing purposes. This sensor is located on the starboard side of the intake manifold behind the upper trim/tilt solenoid.

14- Disconnect the two Brown leads from the air temperature sensor at their quick disconnect fittings. Obtain an ohmmeter and select the Rx1000 ohm scale. Make contact with the two meter leads across the two Brown leads. The meter should register approximately 8, (in reality 8,000 ohms). If the meter registers zero or infinity, the sensor should be replaced. If the meter registers in the kilo-ohm range, the sensor is probaby okay.

Coolant Temperature Sensor Resistance Test

15- Identify the two Black/Tan leads from the coolant temperature sensor loca-



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ted in the port head. Obtain an ohmmeter and select the Rx1000 ohm scale. Make contact with the two meter leads across the two sensor leads. The meter should register approximately 1, (in reality 1,000 ohms). If the meter registers zero or infinity, the sensor should be replaced. If the meter registers in the kilo-ohm range, the sensor is probably satisfactory.

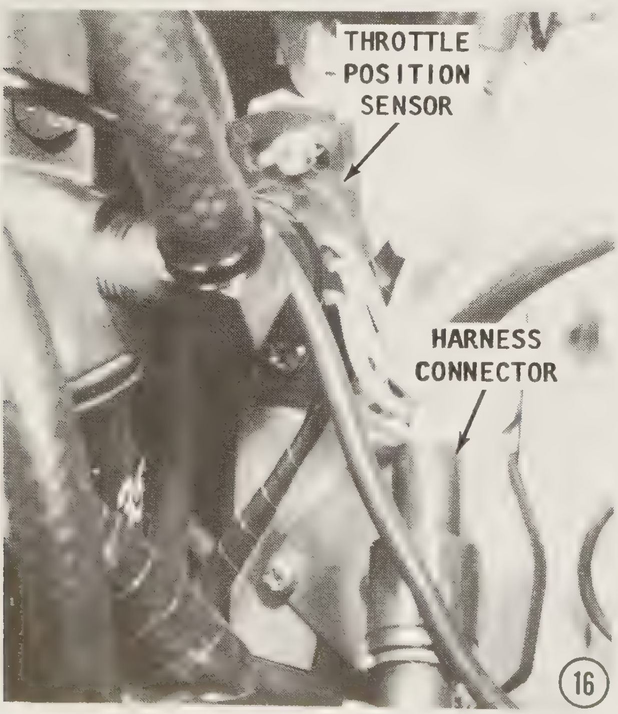
Throttle Position Sensor Resistance Test

Mark the original location of the throttle position sensor **BEFORE** performing any tests on the sensor which may lead to disturbing its original alignment. If this sensor is disturbed during testing or service procedures, a **DIGITAL** type voltmeter is needed to correctly reset the sensor on its mounting bracket, because voltages in the 1/10 range must be accurately read. A misaligned sensor could send misleading signals to the ECU and consequently affect the fuel delivery and ignition timing.

16- Mount the outboard in a test tank, or on a boat in a body of water.

RUNAWAY POWERHEAD

Never operate the powerhead above a fast idle with a flush attachment connected to the lower unit. Operating the powerhead at a high rpm with no load on the propeller shaft could cause the powerhead to **RUNAWAY** causing extensive damage to the unit.



Start the powerhead and allow it to run at 650 rpm until warmed to operating temperature.

CAUTION

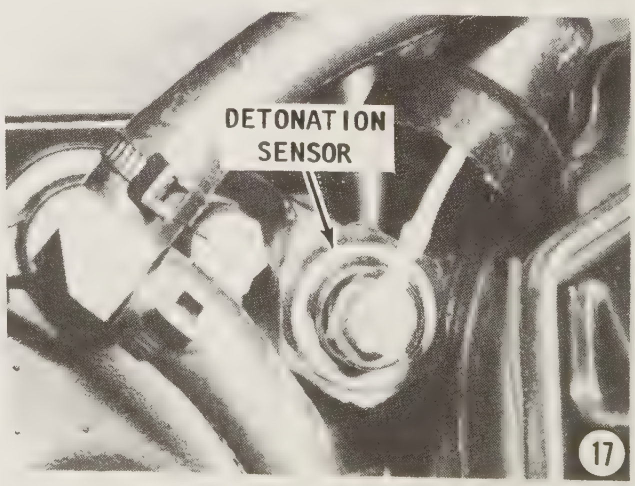
Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

DO NOT remove or change the throttle sensor position during the following test. Disconnect the wire harness from the sensor consisting of Orange, Light Blue and Tan/-Black leads at the harness connector. Obtain an ohmmeter and select the Rx1000 scale. Make contact with the Red meter lead to the Orange sensor terminal. Make contact with the Black meter lead to the Tan/Black sensor terminal. The meter should register between 800 and 1200 ohms at idle speed. Retain the Red meter lead in place, and move the Black meter lead to the Light Blue sensor terminal. The meter should register the same reading.

The lower the resistance reading, the leaner the air/fuel mixture. If the powerhead is overheating at idle speeds, perhaps due to an excessively lean mixture, the problem may lie in the throttle position sensor. Conversely, if the powerhead is smoking at idle speeds, due to an overrich mixture, again the problem may lie in a misaligned throttle position sensor.

Checking Detonation Sensor Resistance

17- Remove the single White/Blue lead from the detonation controller to the detonation sensor at the screw terminal of the sensor. Set this Black lead aside.



Obtain an ohmmeter and set the scale to Rx1000 ohms. Make contact with the Red meter lead to the sensor terminal. Make contact with the Black meter lead to a suitable ground on the powerhead. A reading of no continuity (infinite resistance) should register on the meter. If the reading is less than infinity, there is a short in the sensor and the sensor **MUST** be replaced.

Checking Detonation Sensor Control Module

A **DIGITAL** voltmeter is required to perform this test.

18- Disconnect the Gray/White lead between the detonation module and the switchbox at the quick disconnect fitting. Make contact with the Red meter lead to the disconnected lead from the module and make contact with the Black meter lead to a suitable ground on the powerhead. Set the meter to the 10VDC scale.

Mount the outboard unit in a test tank, or on a boat in a body of water.

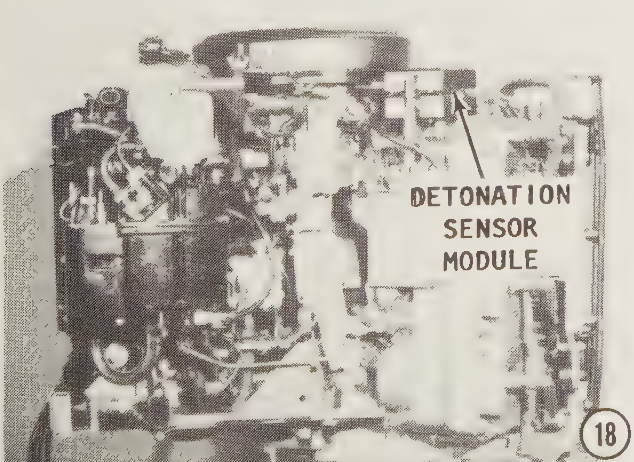
RUNAWAY POWERHEAD

NEVER, AGAIN, NEVER operate the engine at high speed with a flush device attached. The engine, operating at high speed with such a device attached, could **RUNAWAY** from lack of a load on the propeller, causing extensive damage.

Connect a tachometer to the powerhead.

CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.



Start the powerhead and allow it to reach operating temperature at idle speed.

The meter should register only one volt DC. Increase powerhead rpm to between 3500 and 4000. The meter should register zero volts. If the meter registers a fluctuating voltage higher than specified, the powerhead is experiencing detonation. If the meter registers a constant voltage higher than specified, the module is defective.

4-10 EFI FUEL SYSTEM MAINTENANCE

On fuel injected models, preventative maintenance includes checking, repairing or replacing:

loose, broken, cracked, kinked, or disconnected vacuum hoses

loose, corroded, or grounded electrical connections

loose, or improperly supported fuel rails, lines and injectors

dirty primary and/or secondary fuel filters

Even with the high price of fuel, removing gasoline that has been standing unused over a long period of time, is till the easiest and least expensive preventative maintenance possible. In most cases this old gas can be used without harmful effects in an automobile using regular gasoline.

LEADED GASOLINE AND GASOHOL

In the United States, the Environmental Protection Agency (EPA) mandated a national phase-out of leaded fuel -- effective in 1988.

As a result of this "phase-out" of leaded fuel, the manufacturer of the units covered in this manual now recommends the powerheads be operated using regular unleaded gasoline having a minimum octane rating of 86 or higher for all models with standard CDI ignition. The manufacturer also recommends the use of premium unleaded gasoline with a minimum octane rating of 87 or higher for the V6 powerheads equipped with EFI.

Lead in gasoline boosts the octane rating (energy). If the lead is removed, it must be replaced with another agent. Unknown to the general public, many refineries are adding alcohol in an effort to hold the octane rating.

Alcohol in gasoline can have a deteriorating effect on certain fuel system parts. Seals can swell, pump check valves can

swell, diaphragms distort, and other rubber or neoprene composition parts in the fuel system can be affected.

Since about 1981, all manufacturers have made every effort to use materials that will resist the alcohol being added to fuels.

Fuels containing alcohol will slowly absorb moisture from the air. Once the moisture content in the fuel exceeds about 1%, it will separate from the fuel taking the alcohol with it. This water/alcohol mixture will settle to the bottom of the fuel tank. The engine will fail to operate. Therefore, storage of this type of gasoline for use in marine engines is not recommended for more than just a few days.

One temporary, but aggravating, solution to increase the octane of "unleaded" fuel is to purchase some aviation fuel from the local airport. Add about 10 to 15 percent of the tank's capacity to the unleaded fuel.

REMOVING FUEL FROM EFI SYSTEM

For many years there has been the widespread belief that simply shutting off the fuel at the tank and then running the powerhead until it stops is the proper procedure before storing the engine for any length of time. Right? **WRONG.**

It is **NOT** possible to remove all fuel in the system by operating the powerhead until it stops. Some fuel is trapped in the float chamber of the vapor separator, electric fuel pump, fuel filters, fuel pressure regulator and other passages and in the line leading to the fuel rail. The **ONLY** guaranteed method of removing **ALL** fuel is to take the time to drain the fuel completely from the system.

On fuel injected units, the manufacturer recommends the following procedure:

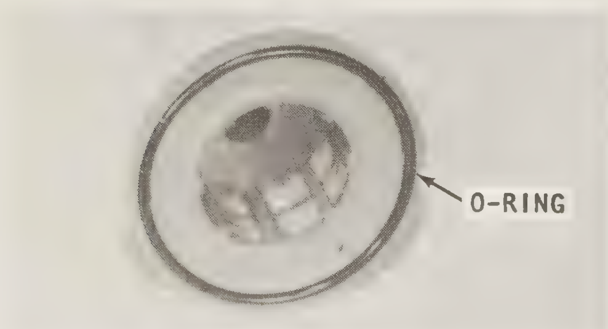
Prepare a mixture of 50:1 sufficient to keep the powerhead operating for ten minutes at idle speed. This mixture of 50:1 will provide an actual running mixture of 25:1 for operation.

CAUTION

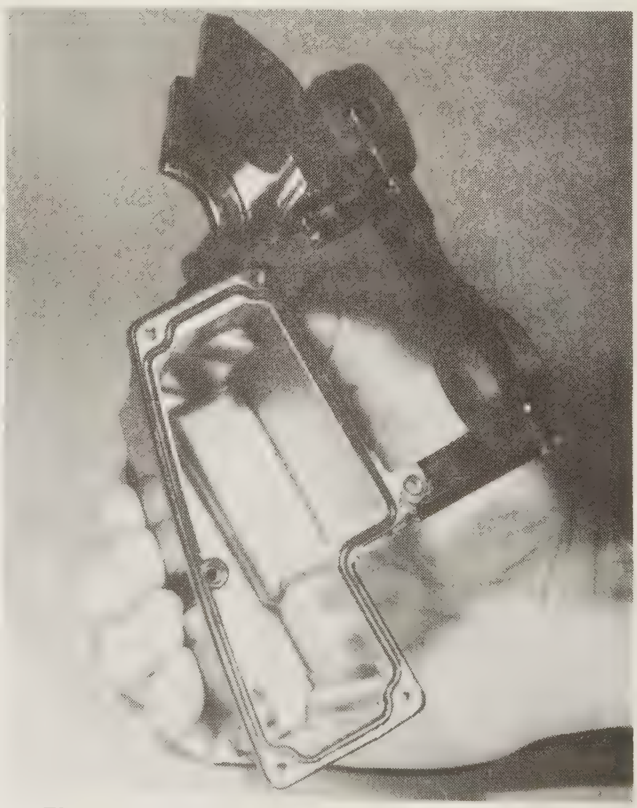
Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

Start the powerhead and allow it to idle for about ten minutes. Disconnect the fuel supply from the tank at the fuel joint and allow the powerhead to die on its own from lack of fuel. Remove all the spark plugs and pour a couple of tablespoons of Quicksilver 2-Cycle Outboard Oil or a suitable substitute, into each spark plug opening. Place a socket over the flywheel nut and rotate the crankshaft **CLOCKWISE** through a few revolutions to evenly distribute and coat the internal powerhead parts with the oil. Install the spark plugs.

Remove the water separating filter and inspect the fluid draining from the filter. This filter should be changed each season or more frequently if purchased fuel is found to be contaminated. Remove the inlet hose



An EFI secondary filter screen with the sealing O-ring in place.



The vapor separator fuel bowl removed as part of the fuel draining procedure, as explained in the text.

to the electric fuel pump and drain the contents of the vapor separator and as much as possible from the electric fuel pump. **DO NOT ATTEMPT TO OPEN THE ELECTRIC FUEL PUMP.** This pump is a sealed unit and **MUST** remain airtight.

Remove and drain fuel from the in-line fuel filter, if so equipped. **CAREFULLY** remove the cap from the secondary fuel filter. If any fuel remains in this filter after the powerhead has run dry, it will be under pressure from the electric fuel pump, therefore, release the cap slowly with a shop towel handy to soak up the fuel. Take the time to clean and inspect the fine wire mesh filter and wipe clean the inside of the cap and filter body.

4-11 SERVICING EFI

The following service procedures are divided into three parts.

First Part

The first portion covers servicing the intake manifold and the fuel injectors. Various sensors are attached to the intake manifold. These sensors may remain undisturbed because they do not affect the procedures. If the sensors themselves are to be removed and serviced, it is not necessary to remove the intake manifold, but merely to disconnect the wire harness or leads at quick disconnect fittings, remove the attaching hardware, and then remove the sensor from the powerhead.

Sometimes, as in the instance of the air temperature sensor, other components must be removed in order to gain access to the attaching hardware of the sensor. If servicing the throttle position sensor, mark the original location of the sensor **BEFORE** removal. If this sensor is misaligned during installation, a **DIGITAL** type voltmeter is needed to correctly reset the sensor on its mounting bracket, because voltages in the 1/10 range must be accurately read. A misaligned sensor could send misleading signals to the ECU and consequently affect the EFI and the ignition timing.

Second Part

The second portion of this section provides service procedures for the secondary fuel filter, the fuel pressure regulator, electric fuel pump, and the vapor separator. Procedures for these items begin on Page 4-74.

Third Part

The third portion of the section provides service procedures for the throttle position sensor. This sensor requires special adjustment following installation. Procedures for this sensor begin on Page 4-78.

SERVICING INTAKE MANIFOLD AND FUEL INJECTORS

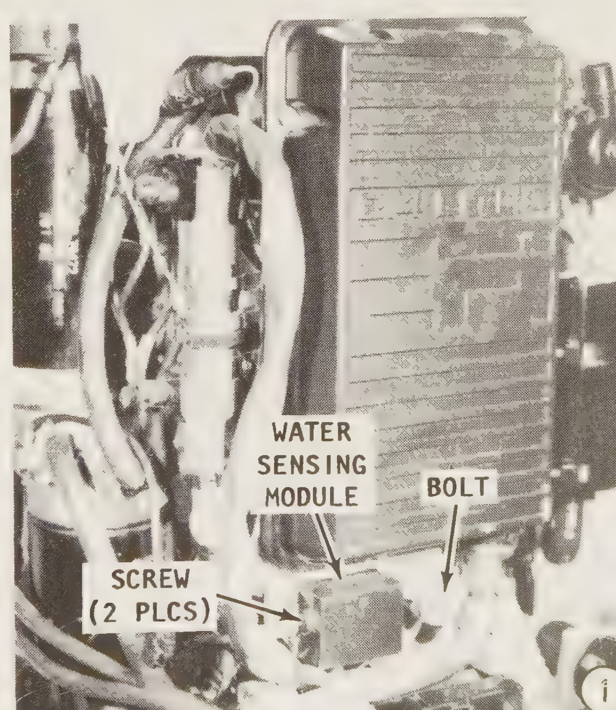
Removal

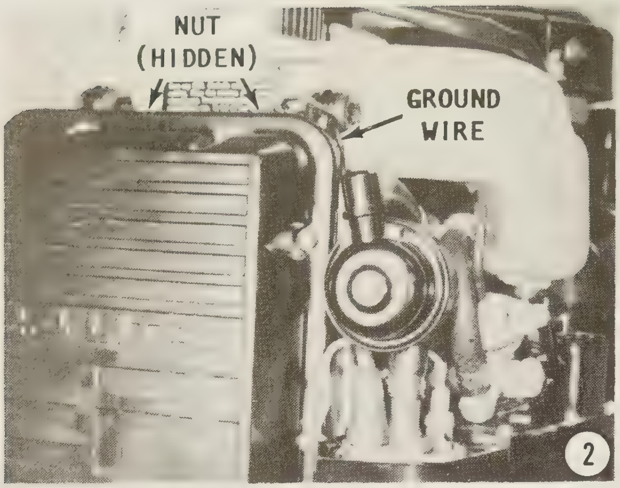
1- Remove the two screws securing the water sensing module to the powerhead. The left screw has two small Black grounding leads attached. The module will still be connected to the powerhead by other leads. Move the module aside. Remove the large bolt in the center at the base of the ECU.

SPECIAL WORDS

DO NOT disturb the small Phillips head screws around the perimeter of the ECU. The cover of the ECU will not come away once these bolts are removed. The bolts were installed during manufacture of the unit, and then the cover and the case were hermetically sealed using the Phillips head screws for alignment. Therefore, no purpose will be served, if these screws are removed.

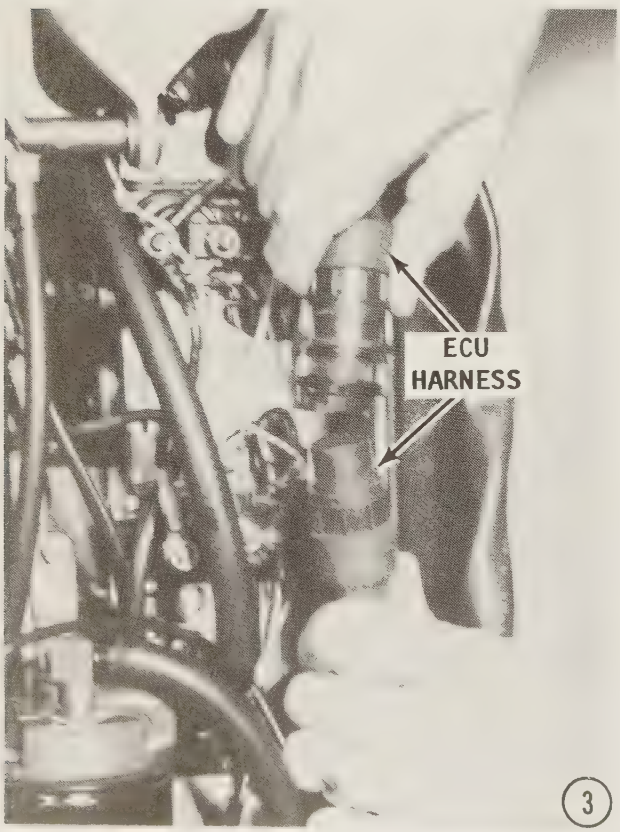
2- Remove the two nuts on the studs at the top of the ECU. The right stud has a small Black ground wire over it.

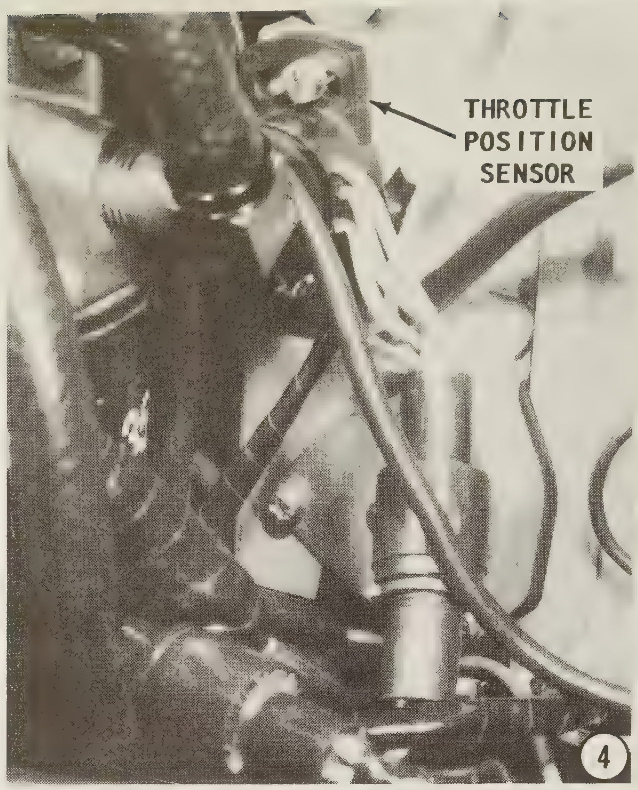




GOOD WORDS

It is far easier to disconnect leads and leave components still attached to the intake manifold, because some components are mounted behind others and should not be disturbed. For example: if the throttle position sensor is misaligned during installation, a **DIGITAL** type voltmeter is required to correctly reset the sensor on its mounting bracket. Voltage in the 1/10 range must be accurately read. A misaligned sensor could send misleading signals to the ECU and consequently affect the EFI and the ignition timing.

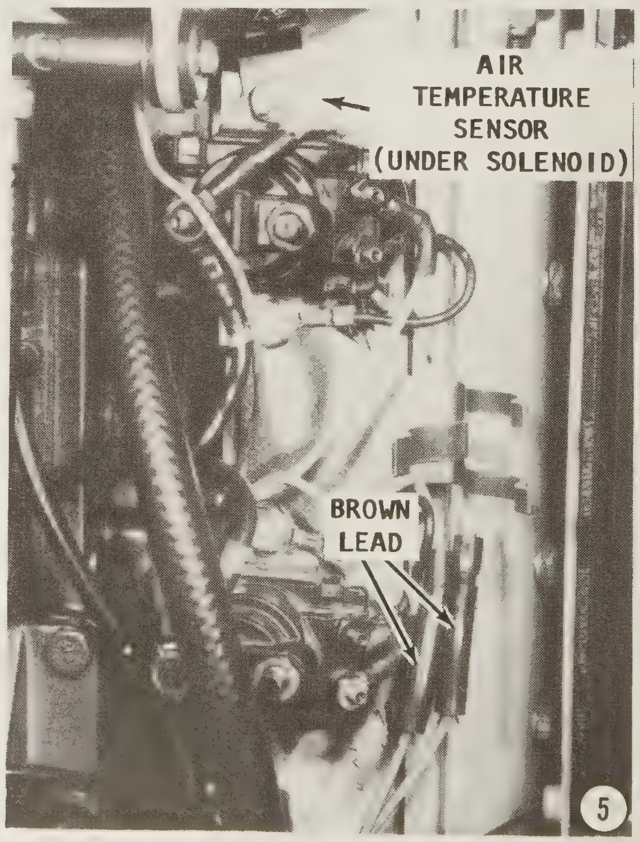


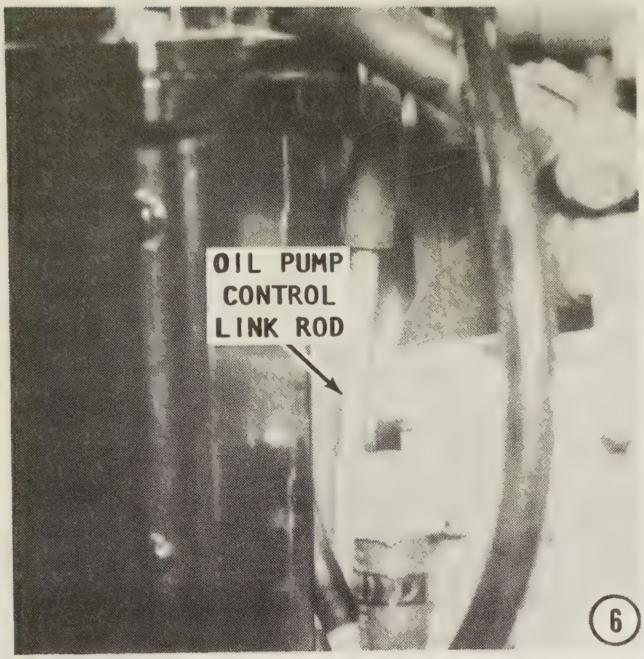


3- Disconnect the main harness plug.

4- Disconnect the throttle position sensor harness plug.

5- Disconnect the two leads from the air temperature sensor at their quick discon-



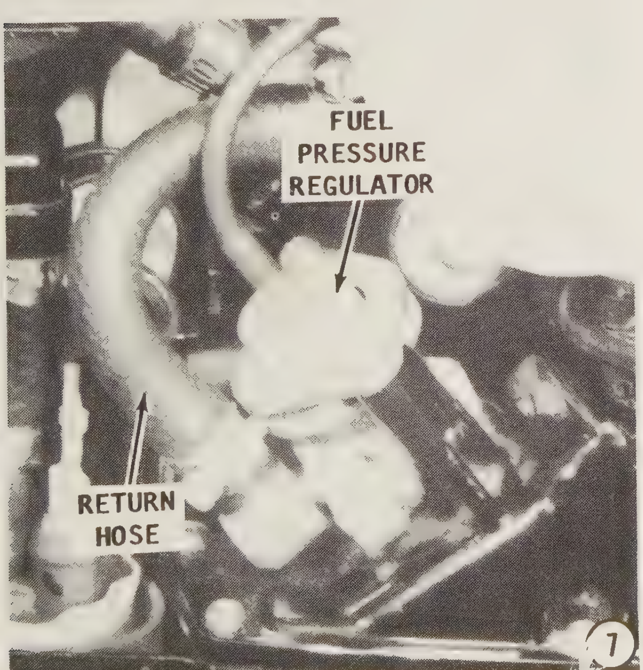


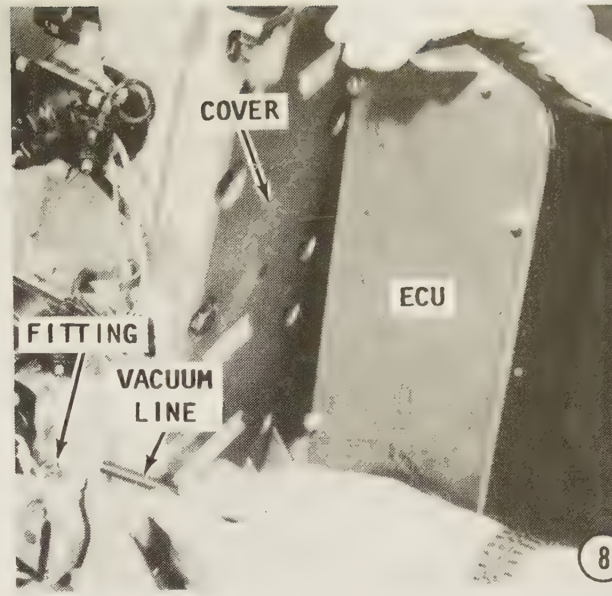
nect fittings. Disconnect the leads to the **UP** and **DOWN** trim/tilt solenoids. Disconnect the fuel injector plug harness.

6- Pry the oil pump control link rod from the ball joint on the intake manifold, leaving the rod on the oil pump. Disconnect the throttle control link rod from the throttle cam.

GOOD ADVICE

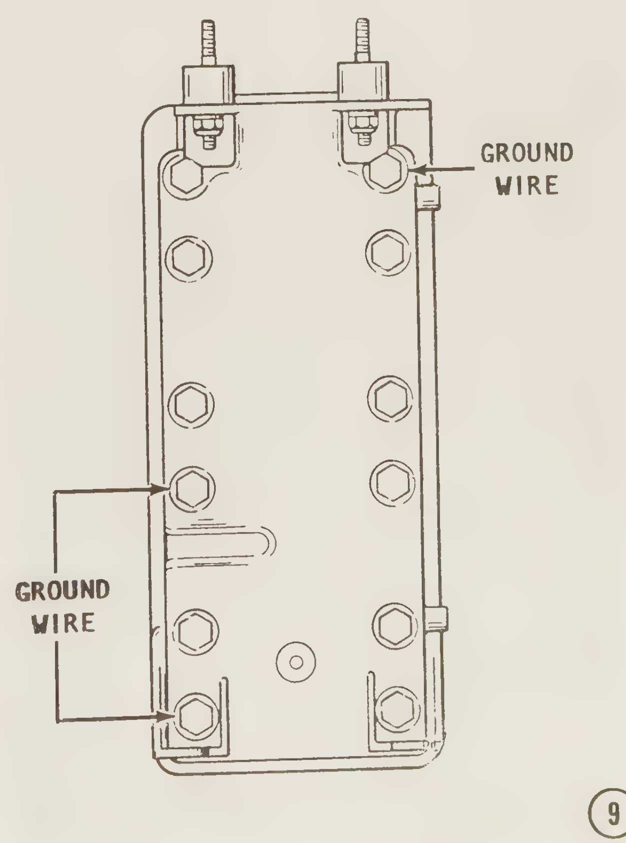
Three vacuum hoses connect the intake manifold to the vapor separator, the fuel pressure regulator and the ECU. Identify these hoses and tag each one as an assist in later installation.





Gently ease the two vacuum hoses free. One hose leads to the fuel pressure regulator and the other hose leads to the vapor separator. Loosen the clamp from the fuel supply hose at the secondary filter, and gently pull the hose free of the filter fitting.

7- Loosen the clamp and remove the return fuel hose from the fitting at the fuel



pressure regulator. Lift off the cowling bracket which supported the ECU. Remove the two bolts from the lower support bracket.

8- Disconnect the vacuum line from the ECU at the fitting on the manifold next to the pressure port. Remove the ECU from the front cover.

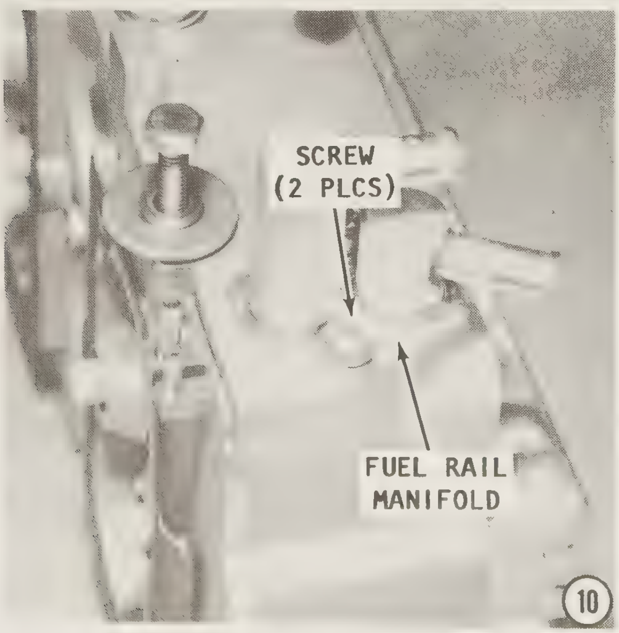
9- Note the location of the three grounding leads on the front face of the intake manifold cover, as an aid during installation. Remove the twelve bolts securing the manifold to the powerhead. Notice all bolts are not the same length. Make a note as to length and location.

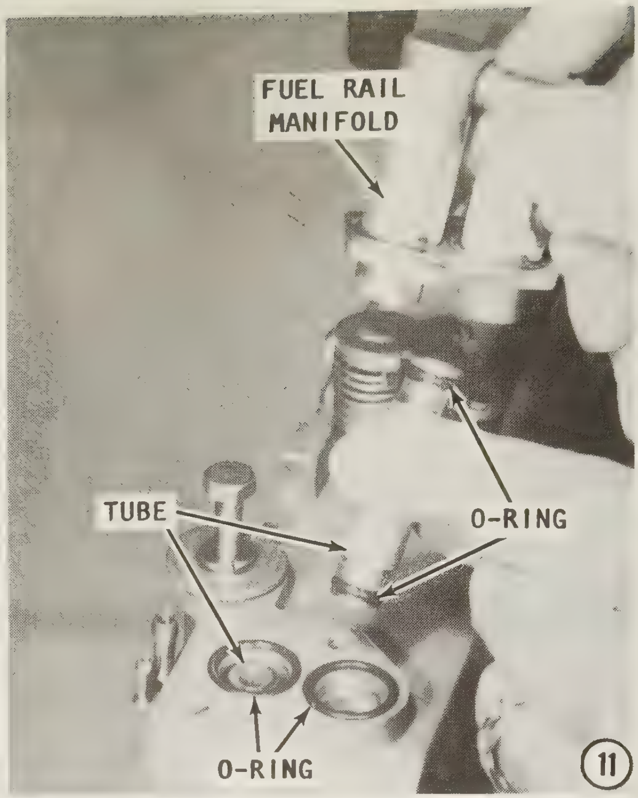
Lift the intake manifold from the powerhead. Remove and discard the gasket. Remove the front cover and gasket from the manifold.

10- Remove the two Phillips head screws with captive lockwashers from the fuel rail manifold.

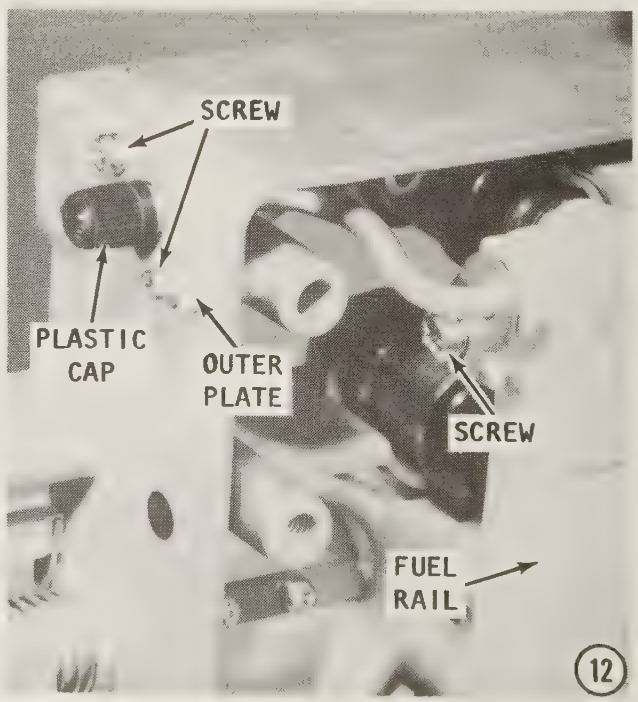
11- Gently pull the fuel rail manifold from the intake manifold. Two tubes are installed under the fuel rail manifold which will either come away with the fuel rail manifold or stay inside the intake manifold. Remove the two tubes. Both tubes are identical and have an **O**-ring at each end. The O-rings need not be removed unless they are no longer fit for service. Remove the two O-rings which seal the fuel rail-to-intake manifolds.

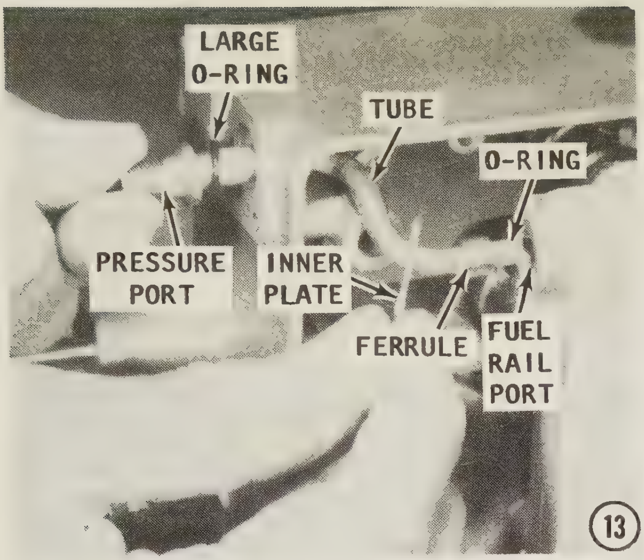
12- Remove the plastic cap from the pressure port on the side of the intake manifold. Remove the two Phillips head screws with captive lockwashers and the outer plate securing the port to the manifold. Remove the Phillips head screw with captive lockwasher from the fuel rail.





13- Ease out the pressure port fitting. As the port is pulled just slightly from the seated position, the attached tube will come out of the fuel rail. A number of small items along the length of this tube must be accounted for and not lost. First, a small **O**-ring around the pressure port. Next, another small **O**-ring around the tube, then a





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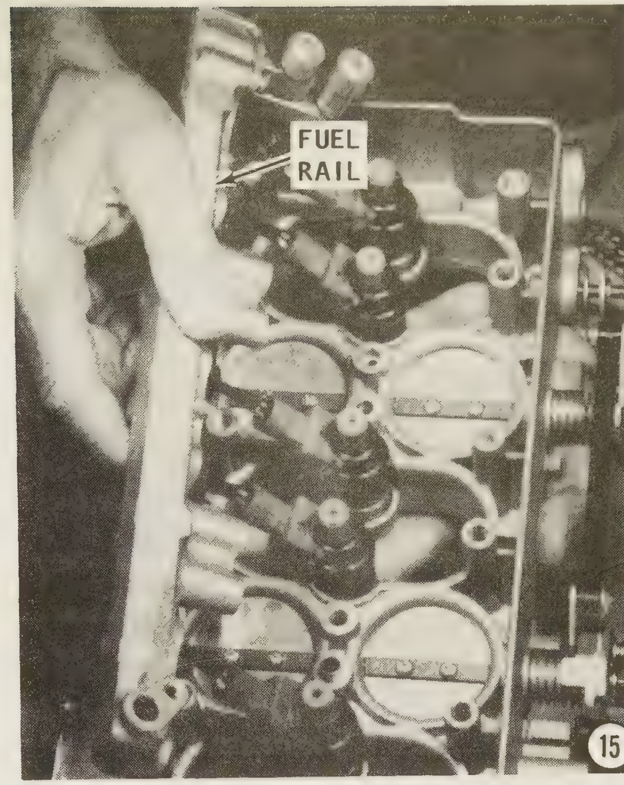
ferrule, and finally an inner plate. The items around the tube cannot be removed until the tube clears the port. The tube may then be guided clear of the manifold.

14- Remove the four long Allen head screws from the injector side of the manifold. Support the fuel rail and turn the manifold over.

15- Separate the fuel rail from the fuel injectors.

16- Remove the two ferrules from the manifold. These two ferrules may have remained either with the manifold or in the fuel rail.



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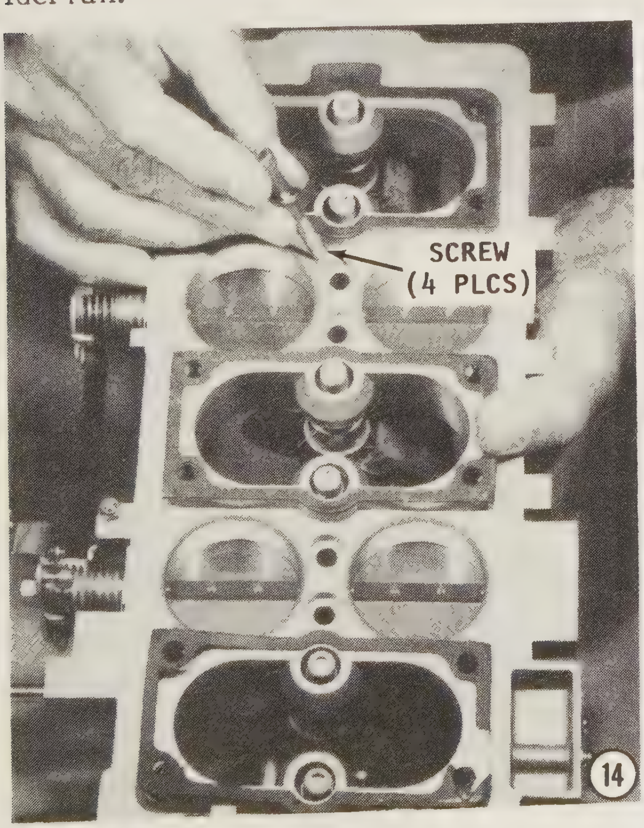
17- Remove the two Phillips head screws with captive lockwashers from the fuel rail support tube. Lift the support tube from the rail. Lift out the two tiny plugs and a total of four O-rings from the rail.

18- Slowly pull each injector straight up and free of the manifold. The injectors are



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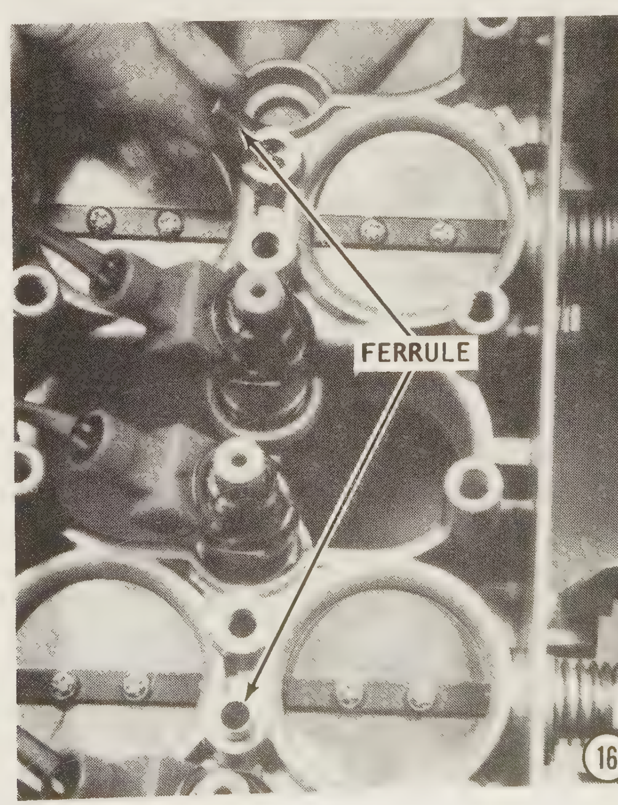

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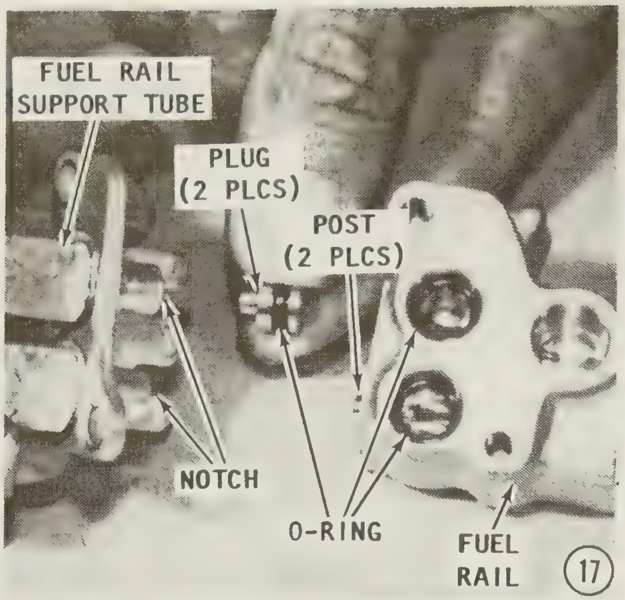
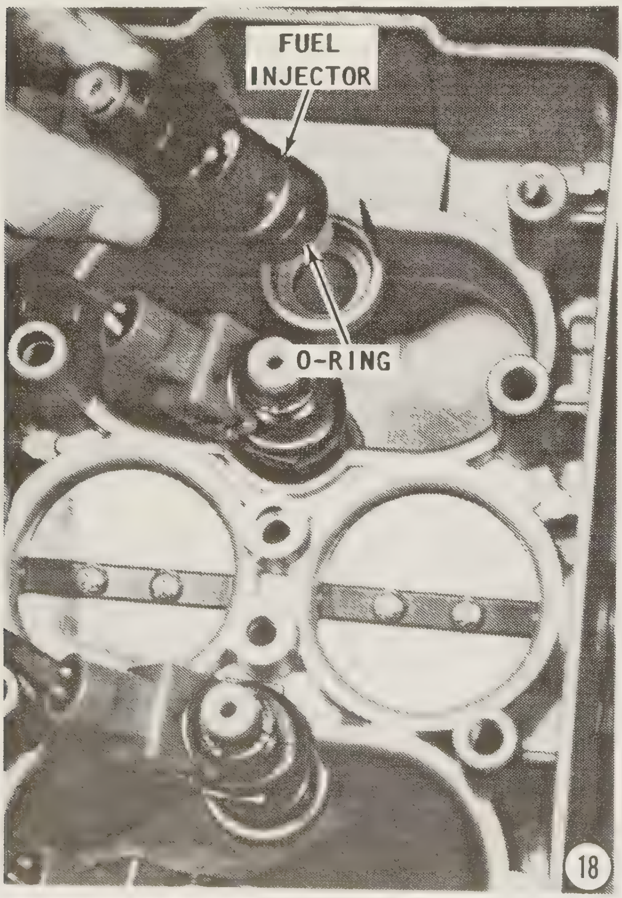
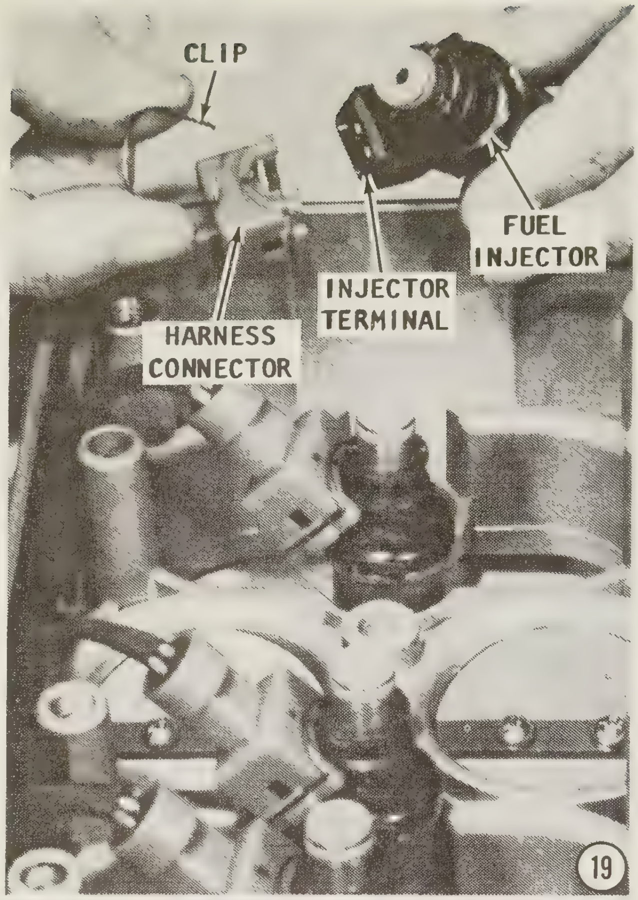
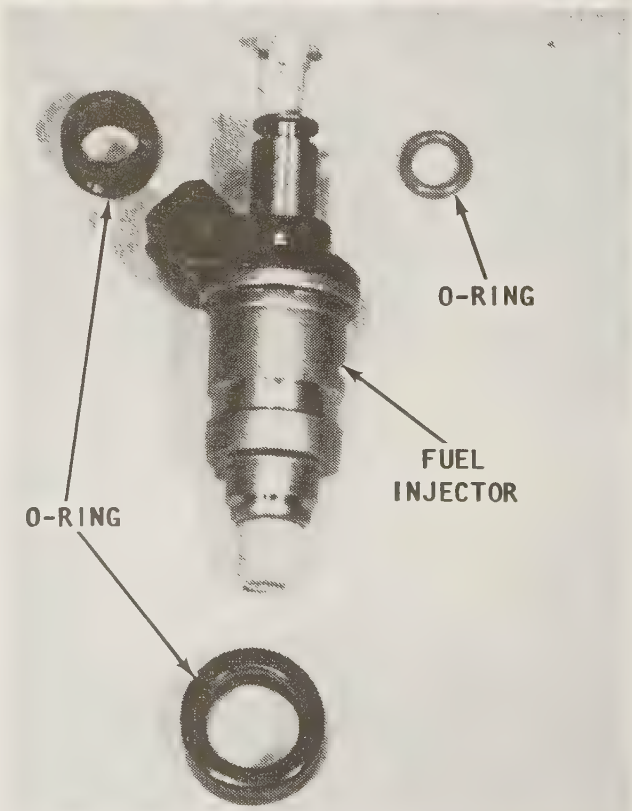


held in the manifold by rubber sealing rings only. These rings may harden or become gummy, depending on use, making removal of the injectors difficult.

19- Using a small slotted screwdriver, pry the retaining clip from the injector harness connector. Disconnect the harness from the injector. Disconnect the harnesses from the other injectors in a similar fashion.







An individual kit containing the necessary O-rings to seal just one injector during installation, may be purchased from the local marine dealer. A new kit for each injector removed should be purchased.

CLEANING AND INSPECTING

The intake manifold, with sensors attached, may be carefully cleaned using a parts brush and solvent. Try not to get the solvent on the sensor or the wire harnesses.

NEVER dip rubber parts or plastic parts in carburetor cleaner. Blow the manifold dry with compressed air.

Move each throttle shaft back-and-forth to check for wear. If any shaft appears to be too loose, replace the manifold. Individual replacement parts are **NOT** available.

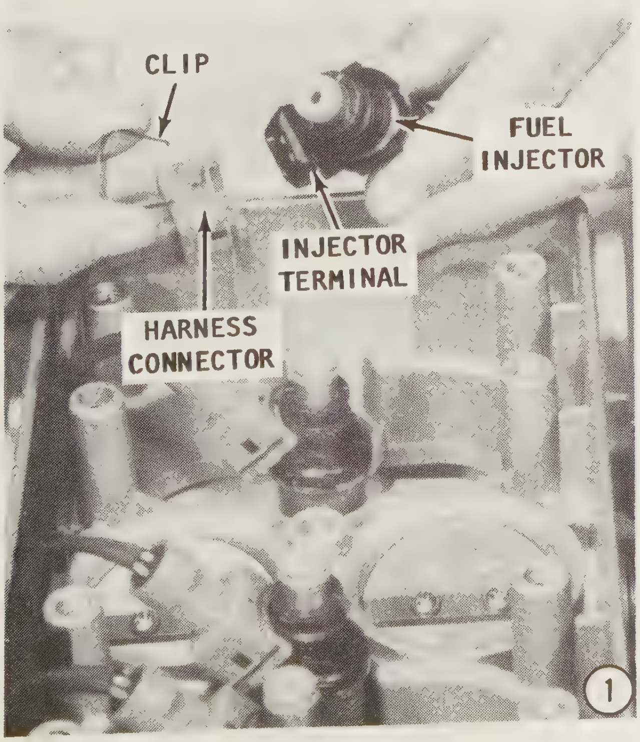
Check action of the throttle return springs. Remove and replace as necessary.

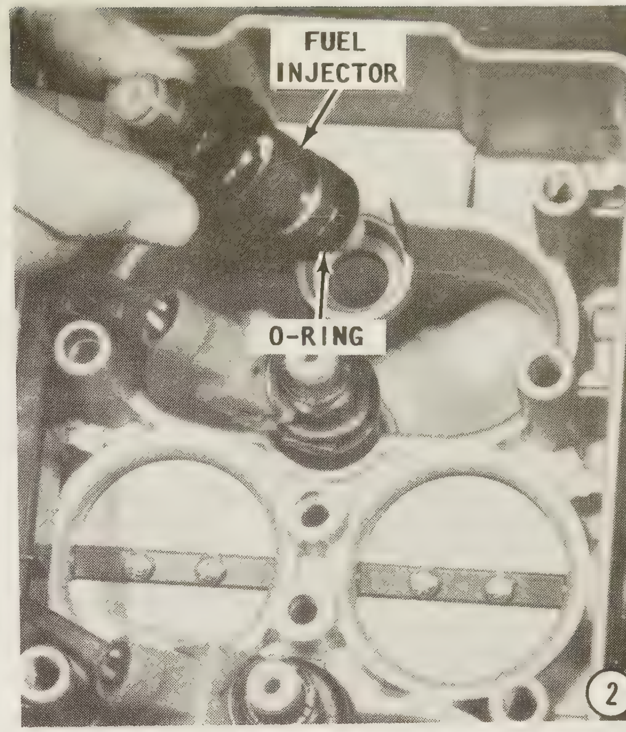
Inspect the main body of the intake manifold and cover gasket surfaces for cracks and burrs which might cause a leak.

A simple test on the internal fuel injector solenoids may be performed as described in Step 13 on Page 4-56.

Two O-rings are used to secure each injector in the fuel rail. One O-ring provides a seal between the injector nozzle and the intake manifold. The other O-ring provides a seal between the injector and the fuel inlet connection. Both O-rings prevent excessive injector vibration. these O-rings are replaceable and are included in an injector overhaul kit.

Inspect the sensors as far as possible without disturbing them. Check the wire harnesses for signs of chafing, cracks, or corroded connections.



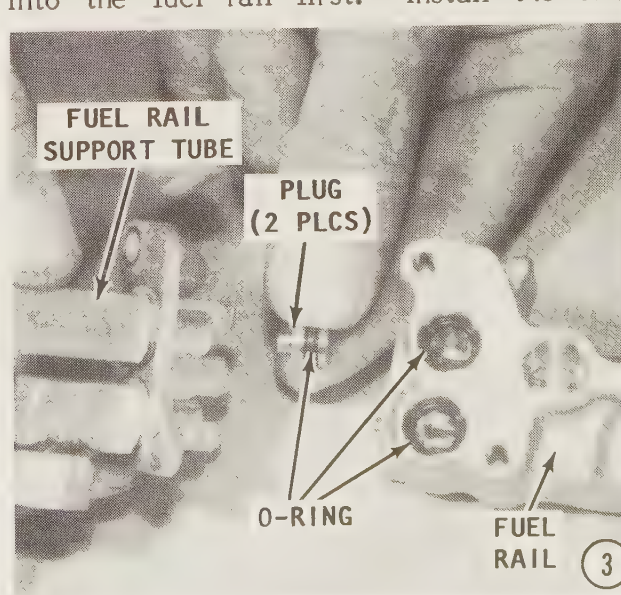


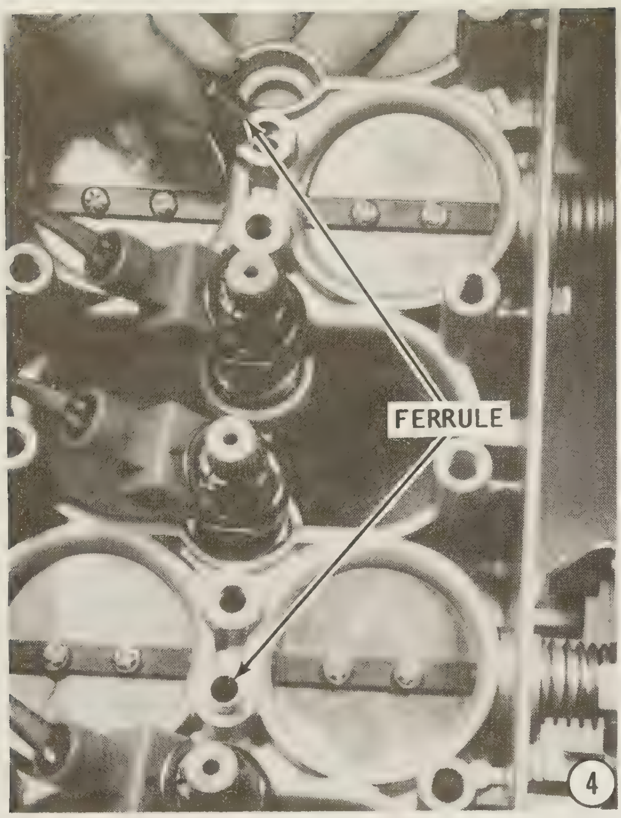
INSTALLATION

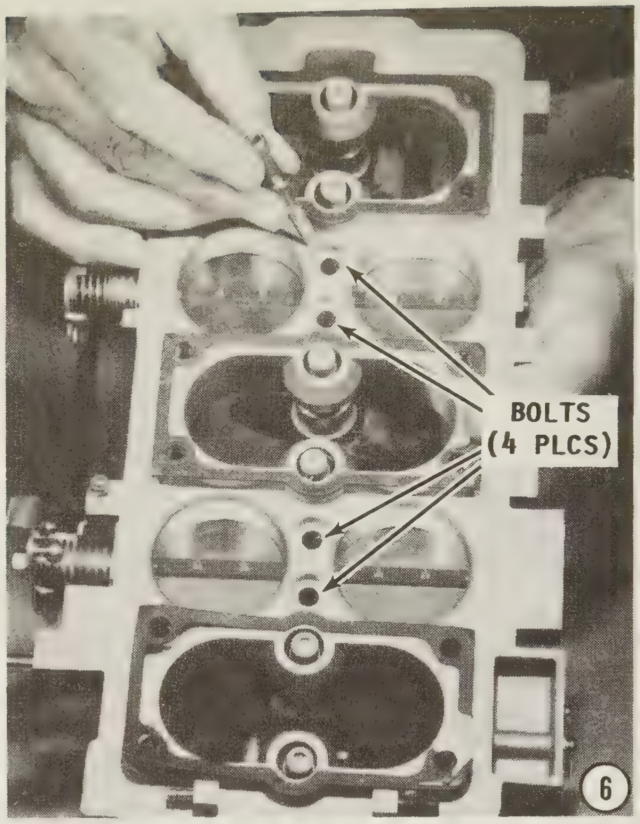
1- Position the retaining clip around the injector wire harness. Push the injector harness connector firmly over the injector terminal. The harness can only be connected one way. Slide the clip into place to secure the harness connector to the injector.

2- Using **NEW** O-rings, push the injector into place to seat firmly into the intake manifold. Repeat Step 1 and this step for all injectors.

3- Install the two tiny plugs into the fuel rail, with the larger end of the plug going into the fuel rail first. Install the two







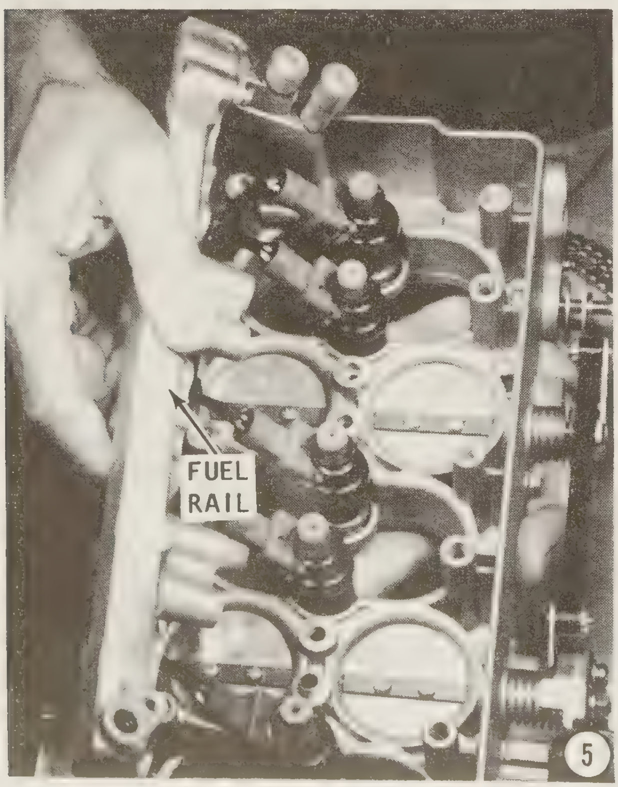
sealing O-rings over the two fuel ports in the rail. Install the fuel rail support tube over the rail with the two notches indexing over the two posts on the rail end. This ensures the support can only be installed one way over the rail. Install and tighten the two Phillips head screws with captive lock-washers.

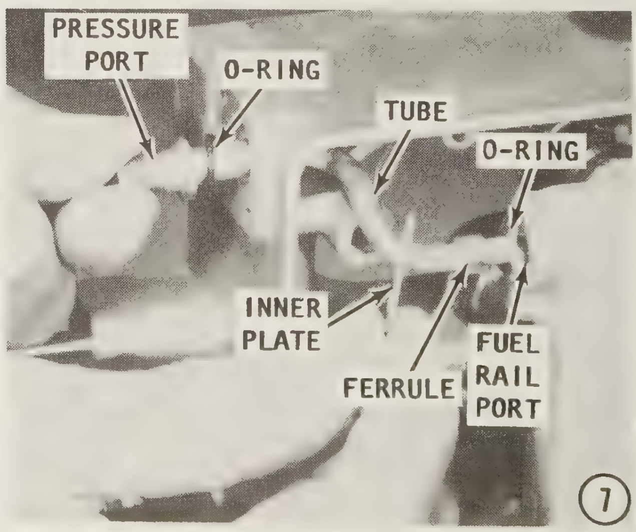
4- Position the two ferrules over the two outer holes in the intake manifold.

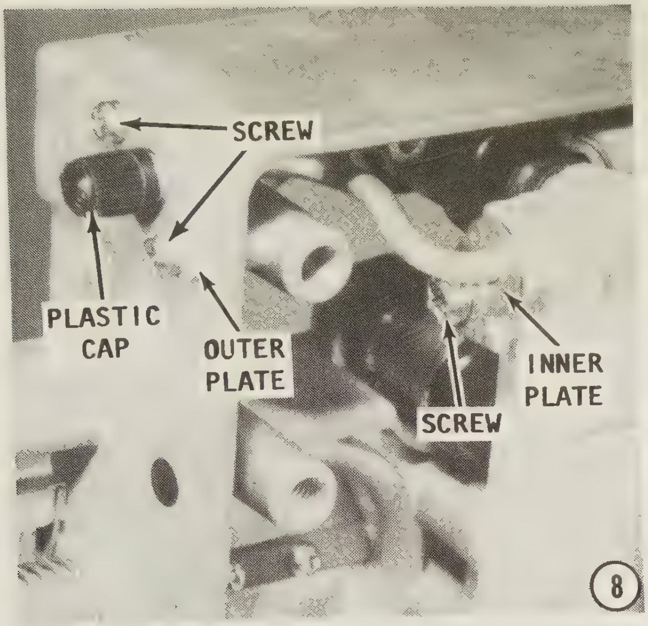
5- Lower the fuel rail over the ferrules and injectors. Make sure the rail is seated properly over each injector and none are askew. Support the rail with one hand and turn the manifold over.

6- Install the four long Allen head bolts. Tighten the bolts alternately and evenly to a torque value of 25 in lb (3.4Nm).

7- Slide the large O-ring over the tube. This O-ring remains on the outside of the

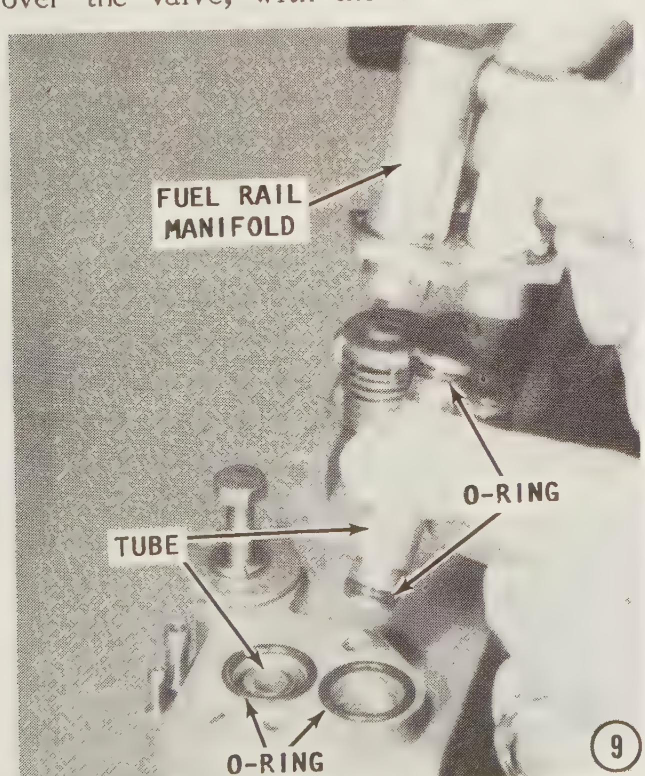


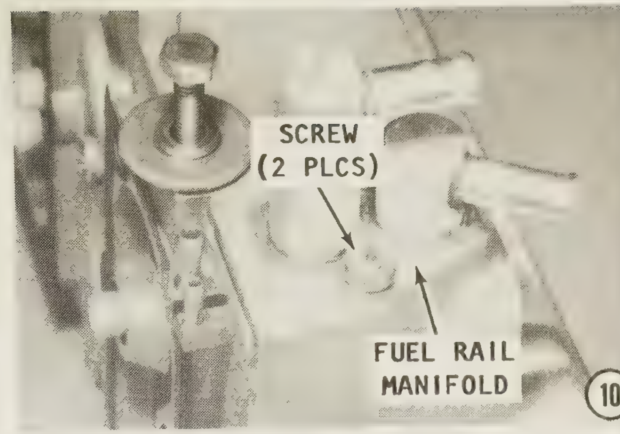




manifold. Insert the tube into the pressure port hole. Over the tube, first slide the inner plate, with the tang on the plate facing toward the rail upon installation, then the ferrule, and finally the small O-ring. Guide the tube into the fuel rail port, with the O-ring and ferrule entering the port first. Secure the inner plate to the rail with the Phillips head screw and captive lock-washer.

8- Seat the pressure port valve and O-ring into the manifold. Slide the outer plate over the valve, with the two screw holes



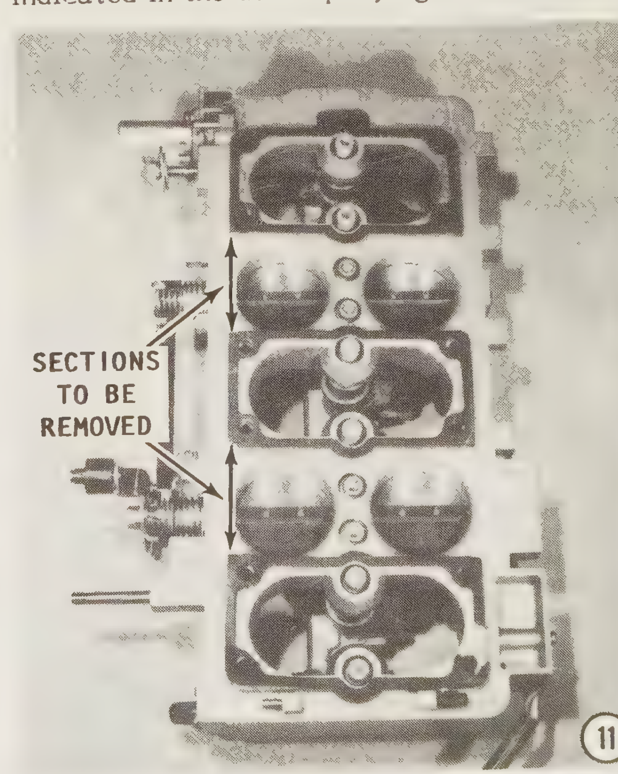


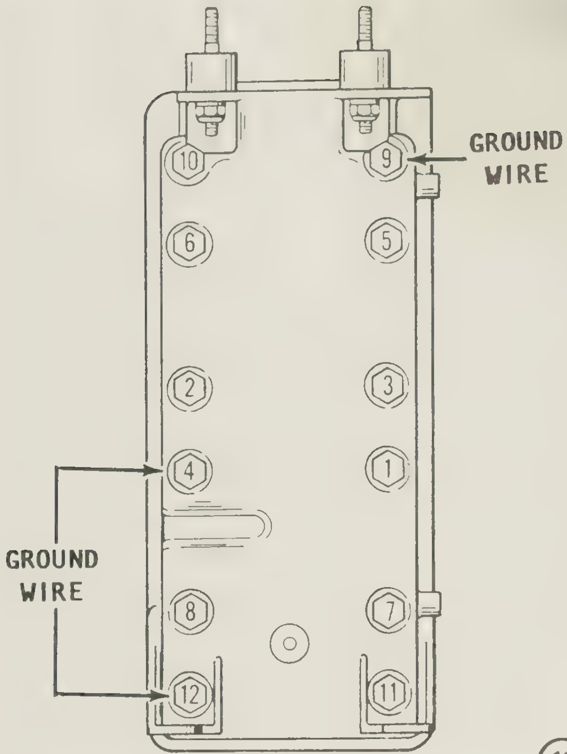
aligned. Install and tighten the two Phillips head screws with captive lockwashers.

9- Insert the two identical tubes, with an O-ring at each end, into the intake manifold. These tubes must seat in the fuel rail support tube. Position two O-rings over the ports. Install the fuel rail manifold over the tubes. The manifold can only be installed properly one way. The bolt holes will not align if the manifold is positioned incorrectly.

10- Install and tighten the two Phillips head screws securing the fuel rail manifold to the intake manifold.

11- Position a new gasket on the intake manifold. This gasket is purchased and installed in one piece. After installation, four sections of the gasket are removed, as indicated in the accompanying illustration.

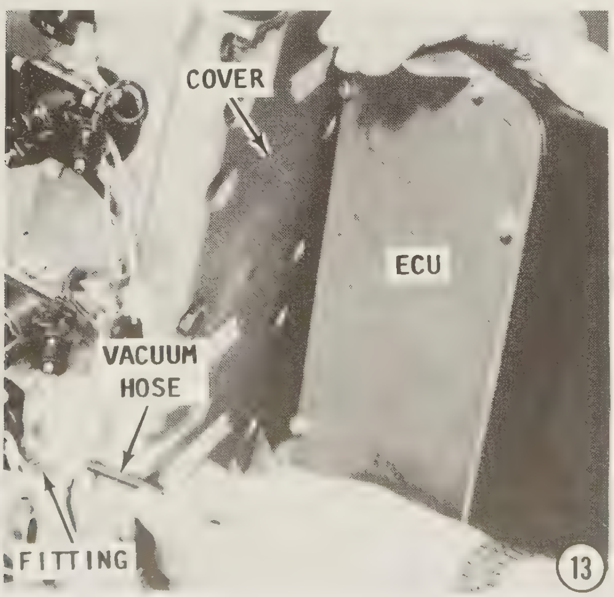




12

12- Install the intake manifold to the powerhead. The securing bolts have different lengths. Bolts identified as No. 4, 12, and 9 have grounding wires attached. Tighten all bolts to a torque value of 90 in lb (10.2Nm) in the sequence shown in the accompanying illustration. Position the top cowling bracket over the two studs on top of the intake manifold.

13- Connect the vacuum hose from the MAP sensor inside the ECU to the fitting on the intake manifold.



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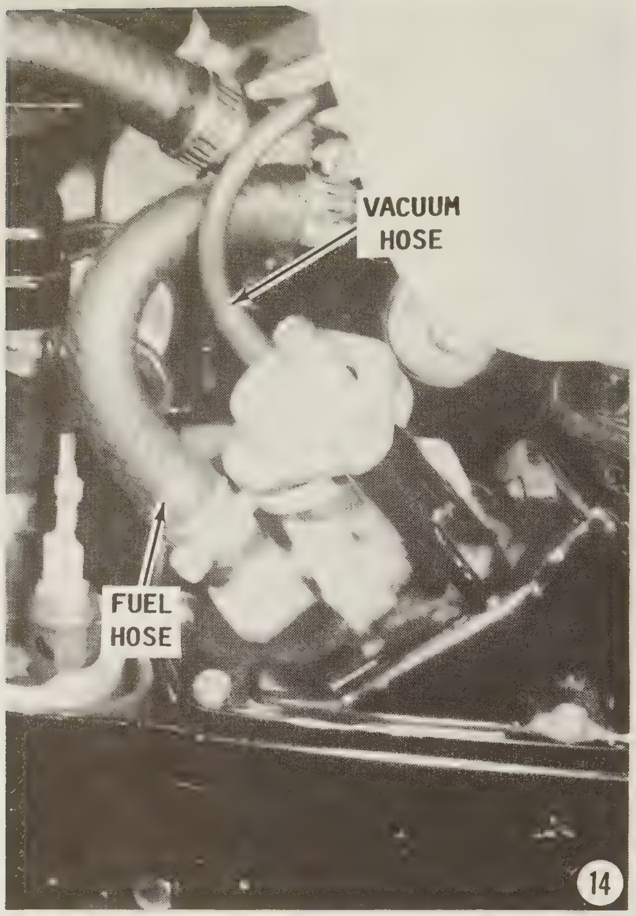

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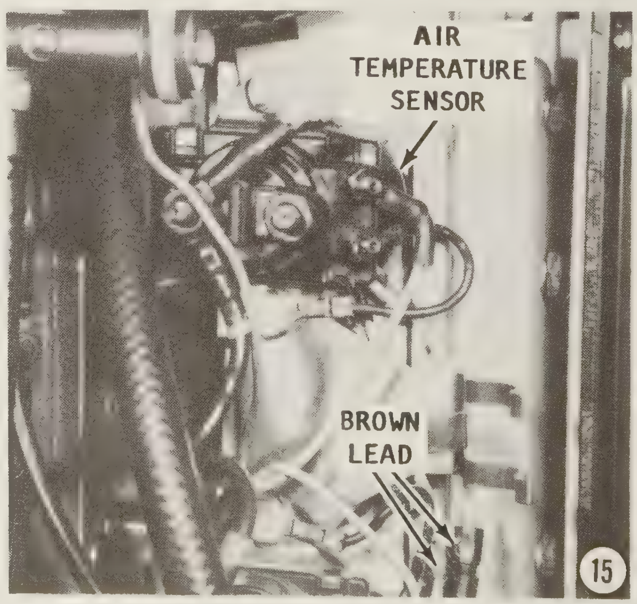
14- Connect the fuel return hose to the fuel pressure regulator and tighten the hose clamp. Connect the vacuum hose from the intake manifold to the fitting on the pressure regulator. Connect the vacuum hose from the intake manifold to the vapor separator.

15- Connect the two Brown leads from the air temperature sensor to the two Brown



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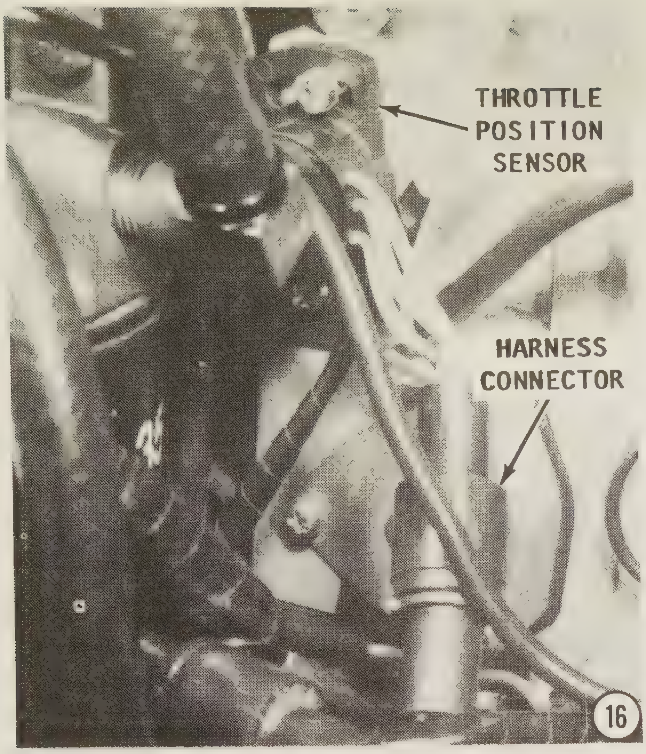
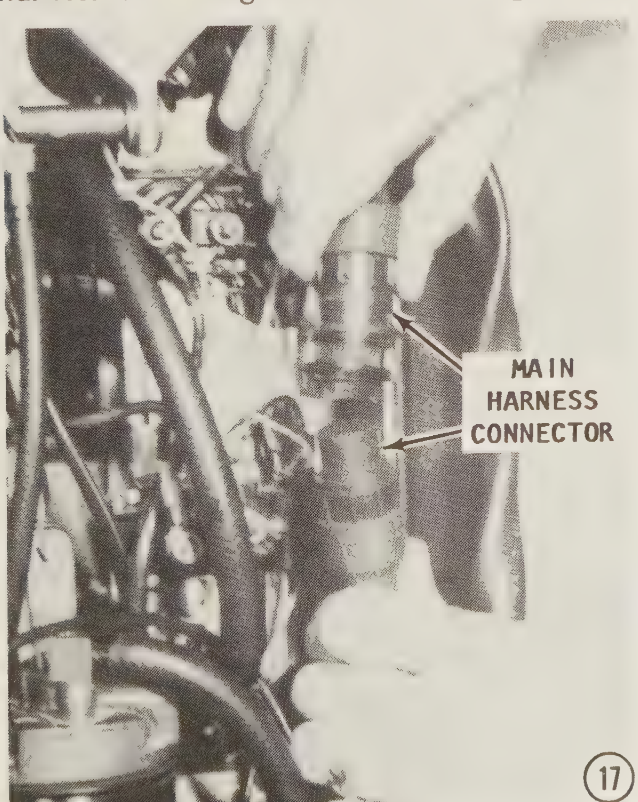
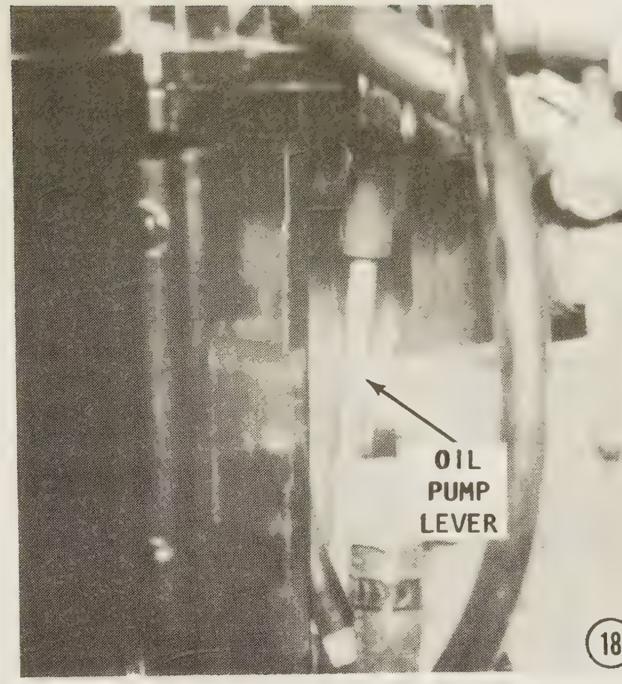


leads from the ECU at their quick connect fittings.

Connect the leads to both trim/tilt solenoids. Consult the wiring diagram in the Appendix as an aid in making these connections.

16- Connect the throttle position sensor harness consisting of Tan/Black, Light Blue



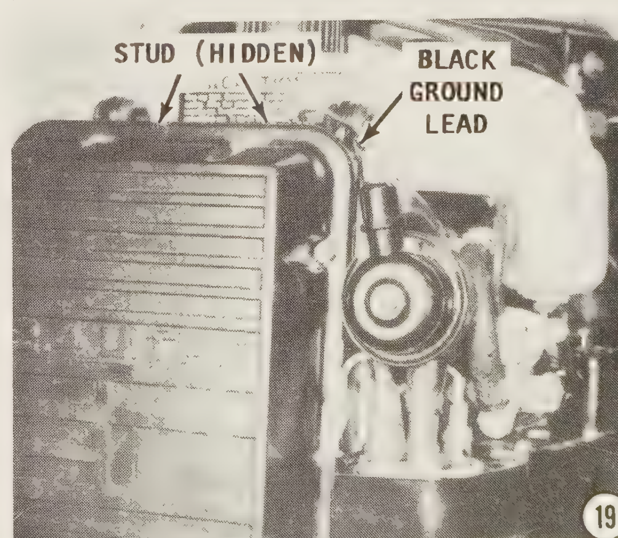


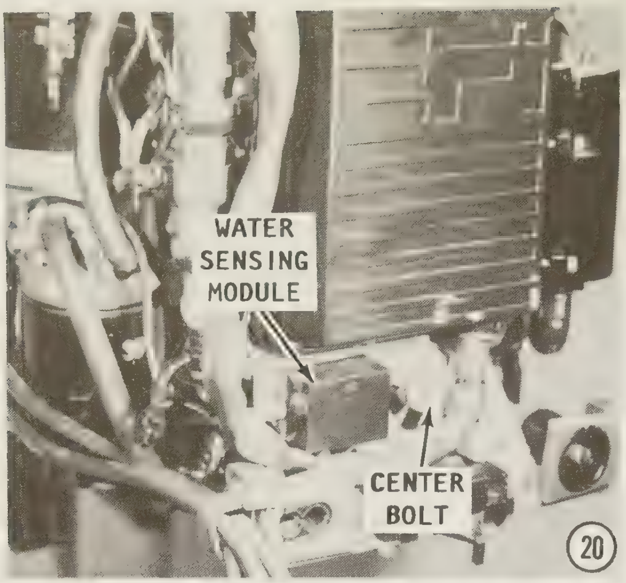
and Orange leads to its harness connector from the ECU. Connect the fuel injector harness consisting of Yellow, Dark Blue, White, and Red leads to its harness connector from the ECU.

17- Connect the ECU wire harness connector to the main powerhead harness connector. The connection can only be made one way.

18- Rotate the oil pump lever **CLOCKWISE** and snap the oil pump control link rod on the ball joint onto the intake manifold throttle linkage. Attach the throttle control link rod to the throttle cam.

19-Slide the ECU down over the two top studs. Slide the small Black ground lead over the right stud. Install and hand tighten the two nuts.





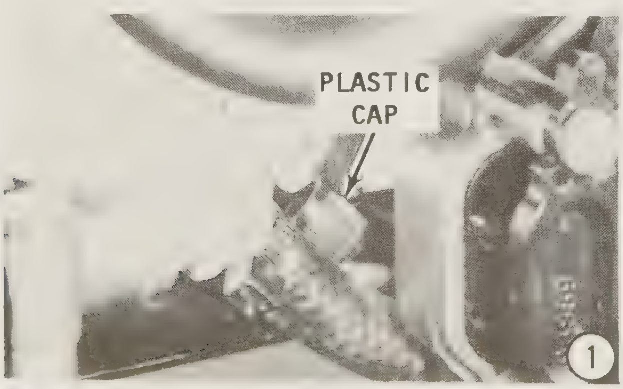
20- Install the single center bolt at the base of the ECU. Tighten this bolt and the two nuts installed in the previous step to a torque value of 45 in lb (5Nm). Install and tighten the two bolts on the lower support bracket. Install the water sensing module below the ECU. The left attaching Phillips head screw also acts as a grounding point for two small Black wires. Install and tighten both securing screws.

SECONDARY FUEL FILTER SERVICE

CRITICAL WORDS

Before the secondary fuel filter cover may be removed, the EFI system **MUST** be depressurized, as described in Step 1.

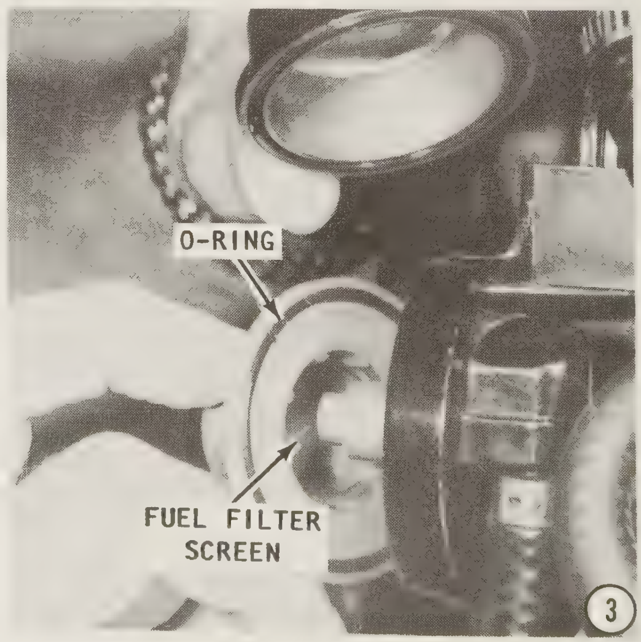
1- Remove the plastic cap over the pressure port located portside at the bottom of the intake manifold. A screwdriver will be used to depress the valve tip to release the pressure and allow fuel to drain from the valve. Place the screwdriver tip lightly over the valve tip and wrap a clean shop towel around the valve and screwdriv-

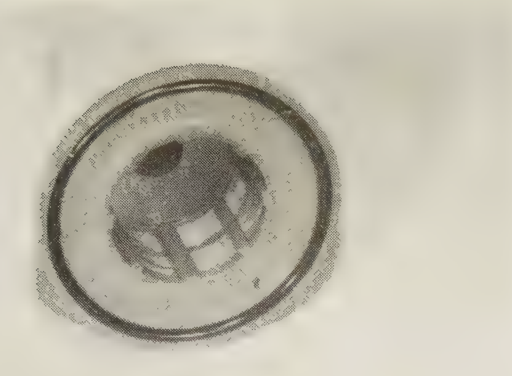


er. This operation is similar to letting air out of tires! Once all the pressure has been released and the fuel flow ceases, **CAREFULLY** proceed with Step 2.

2- Loosen, but do **NOT** remove the center bolt on the filter cover. It is not necessary to remove the inlet fuel hose from the cover. Pry the cover from the filter. Remove the two O-rings. One large O-ring is located around the circumference of the cover and the other smaller O-ring will be found either inside the cover around the securing bolt, or on the filter screen.

3- Remove the filter screen and the large O-ring located around the inner circumference.





The secondary filter and O-ring holds fuel pressure in the system. Therefore, both must be in good condition.

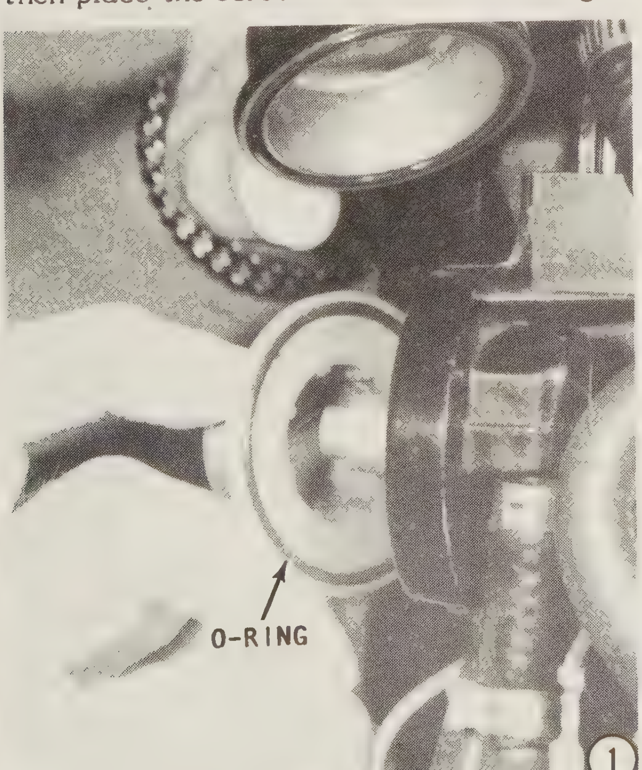
CLEANING AND INSPECTING

All three O-rings should be replaced. If they must be used again, they must be subjected to close inspection. If any O-ring appears to have the **SLIGHTEST** damage or distortion, the O-ring **MUST** be removed, discarded, and replaced. These O-rings provide a seal for fuel under pressure.

The screen can be rinsed in solvent and blown dry with compressed air. If the screen is damaged or distorted, the filter must be replaced.

INSTALLATION

1- Position a new O-ring around the inner circumference of the filter screen, and then place the screen in the filter housing.



2- Position a new O-ring around the circumference of the filter cover and another O-ring inside the cover around the center bolt. Install the filter cover over the filter screen. Tighten the center bolt to a torque valve of 25 in lbs (3Nm).

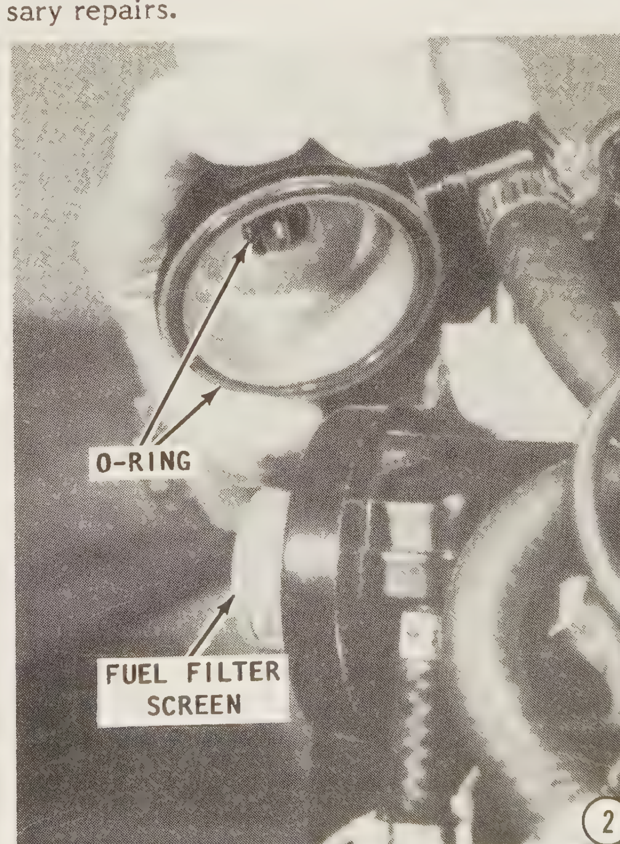
CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

Start the powerhead and check for fuel leaks.

CRITICAL WORDS

The system will be pressurized almost instantly -- as soon as the powerhead is cranked. Watch for leaks around the cover and the center screw of the secondary fuel filter. Because the system is pressurized, a leak will not appear as drips. Instead, fuel will be **SPRAYED** all over the powerhead. Should this occur, shut down the powerhead immediately. **DO NOT** forget to **DEPRESSURIZE** the system at the pressure port on the intake manifold before making necessary repairs.



FUEL PRESSURE REGULATOR, ELECTRIC FUEL PUMP AND VAPOR SEPARATOR

SPECIAL WORDS

The accompanying illustrations sere taken of a fuel pressure regulator and vapor separator removed from the powerhead. If only the fuel regulator is to be serviced, the work may be just as easily performed while the regulator is still in place on the powerhead. However, if the vapor separator is to be serviced, it must be removed from the powerhead. If only the vapor separator is to be serviced and not the fuel pressure regulator, simply skip the steps which pertain to the regulator.

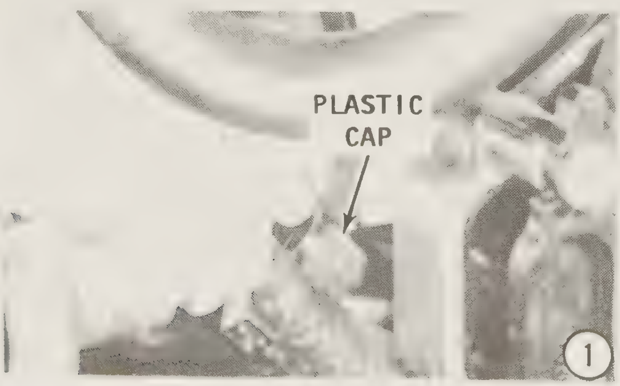
CAUTION

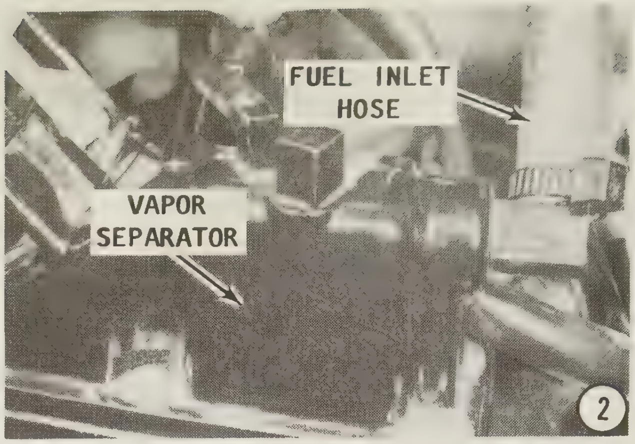
Before the electric fuel pump, vapor separator **OR** the fuel pressure regulator is removed, the EFI system **MUST** be depressurized, as described in Step 1.

1- Remove the plastic cap over the pressure port located portside at the bottom of the intake manifold. A screwdriver will be used to depress the valve tip to release the pressure and allow fuel to drain from the valve. Place the screwdriver tip lightly over the valve tip and wrap a clean shop towel around the valve and screwdriver. This operation is similar to letting air out of tires! Once all the presssure has been released and the fuel flow ceases, **CAREFULLY** proceed with the following step.

2- Remove and plug the fuel inlet hose from the water separating filter to the vapor separator cover fitting.

3- Remove and plug the oil inlet hose at the base of the vapor separator. Obtain a suitable container, then remove and drain the hose from the vapor separator to the electric fuel pump. Disconnect the **Red** and **Red/Purple** leads from the electric fuel pump. Remove the four cover plate mounting bolts and lift off the plate. Disconnect the inlet and outlet hoses from the

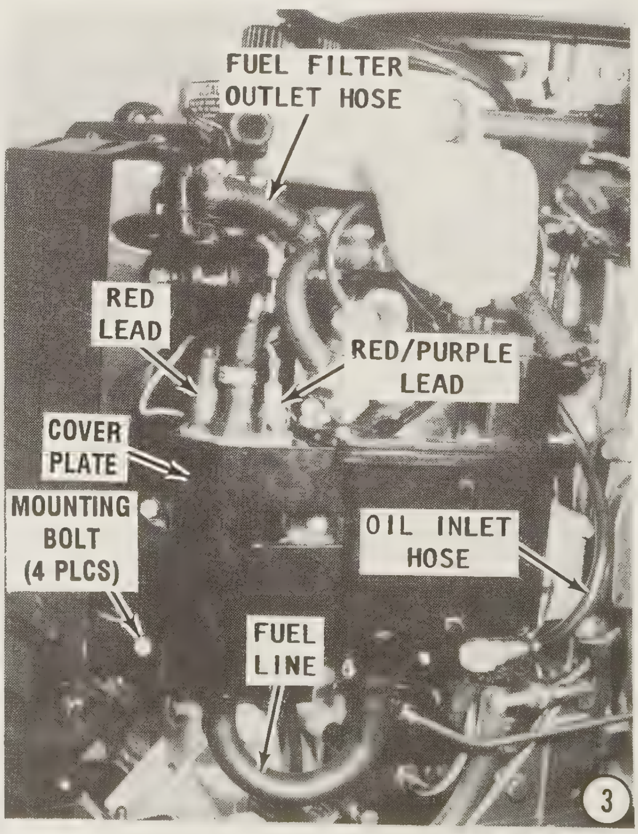


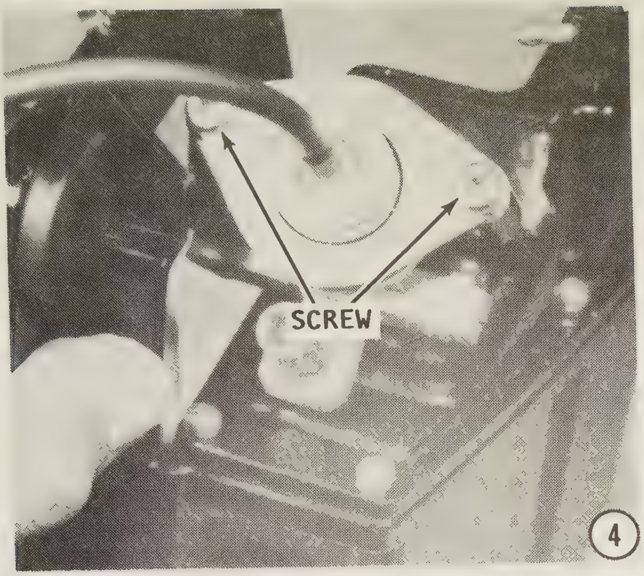


pump. Lift the pump and rubber blanket free of the powerhead. Remove and drain the fuel return hose at the forward end of the fuel pressure regulator to the fitting on the separator cover. Remove the vacuum line from the intake manifold at the fitting on the fuel pressure regulator. Now, remove the two vacuum lines from the fittings on the vapor separator cover. One line is from the intake manifold and the other line from the crankcase regulator.

The vapor separator and fuel regulator assembly is now disconnected from the system ready for removal from the powerhead.

Remove the three attaching bolts, and then remove the assembly from the powerhead.





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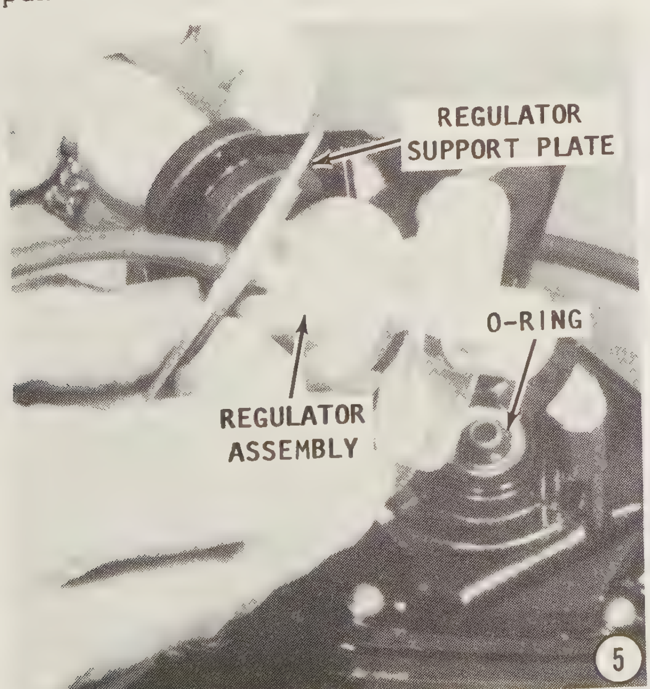
4- Remove the two Phillips head screws with captive lockwashers from the regulator support plate.

5- Remove the regulator from the water separator cover. Remove the O-ring from the separator cover.

6- Remove the two screws securing the regulator to the manifold plate, and then remove the O-ring.

7- Remove the six Phillips head screws with captive lockwashers from the vapor separator cover. Lift the cover slowly and squarely from the housing. The cover will come away with the float assembly attached.

8- Use a pair of needle nose pliers and pull the float hinge pin from the mounting



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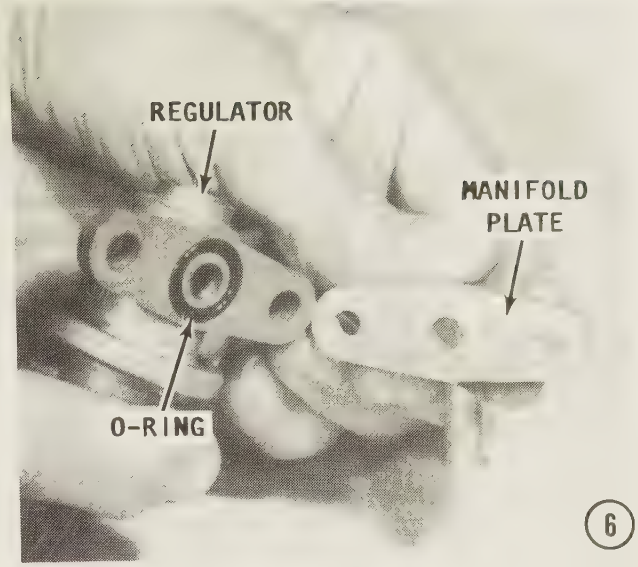

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posts on the cover. Remove the float and inlet needle from the cover. The needle may be slid from the brass tab on the float. **TAKE CARE** not to alter the angle of the brass tab.

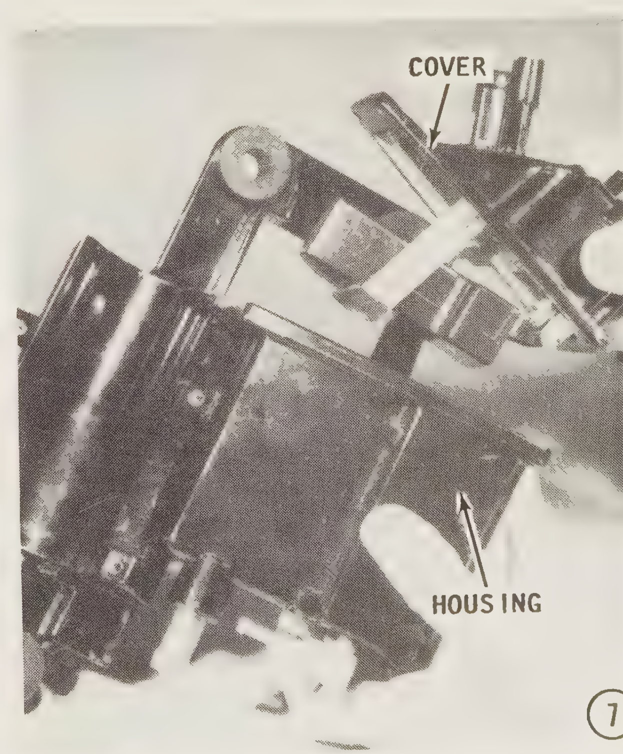
Remove the O-ring from the housing.

CLEANING AND INSPECTING

The inlet needle seat is pressed into the cover, therefore, it is not removeable or replaceable.

Rinse the housing in solvent, and then blow it dry with compressed air.

Check the float for deterioration. The float is hollow, therefore, check to be sure



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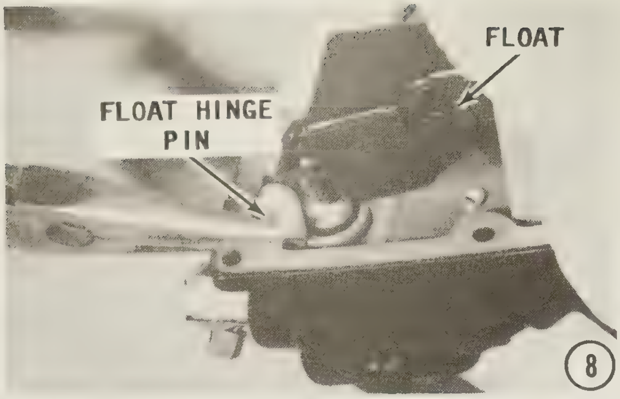
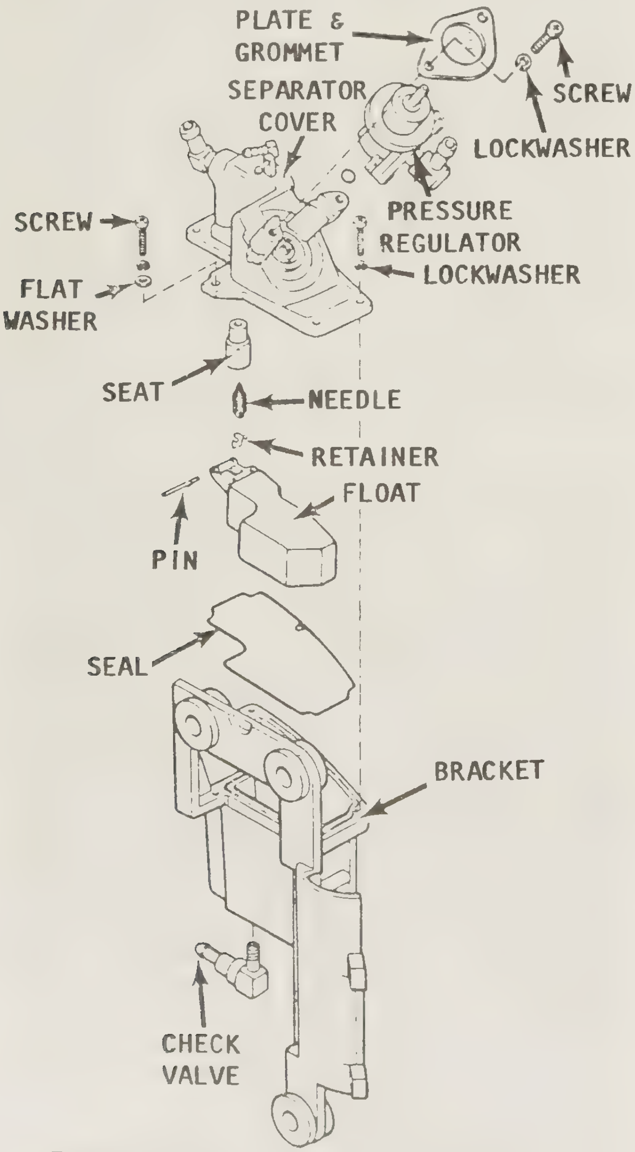
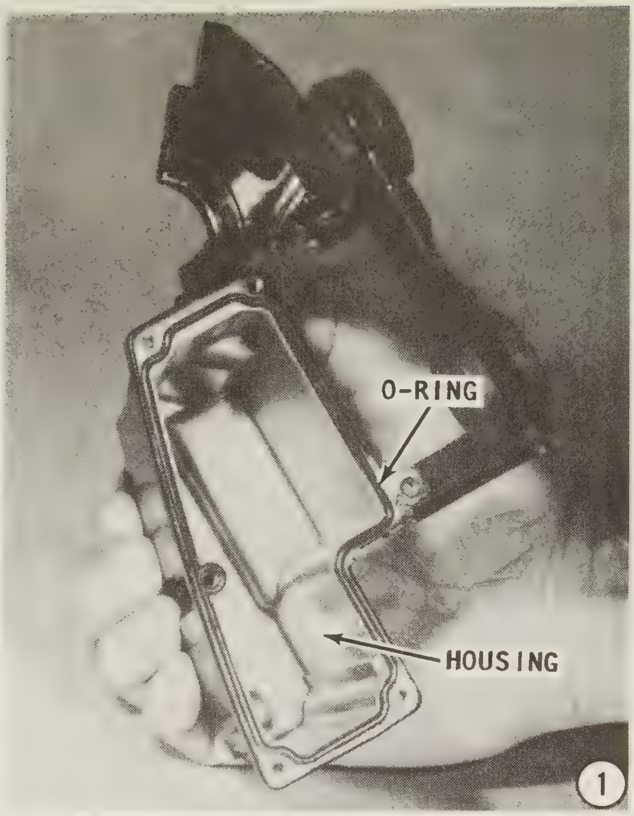


the float does not contain any fluid. Check to be sure the float tab is in good condition. If any part of the float is damaged, the unit must be replaced. Check the float tab-to-needle contacting surface and replace the float if this surface has a groove worn in it.



Exploded drawing of the fuel pressure regulator and vapor separator, with major parts identified.

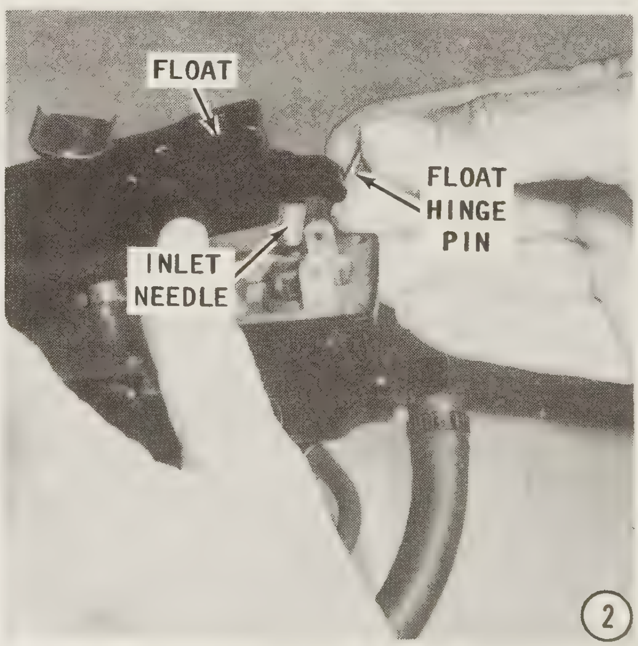


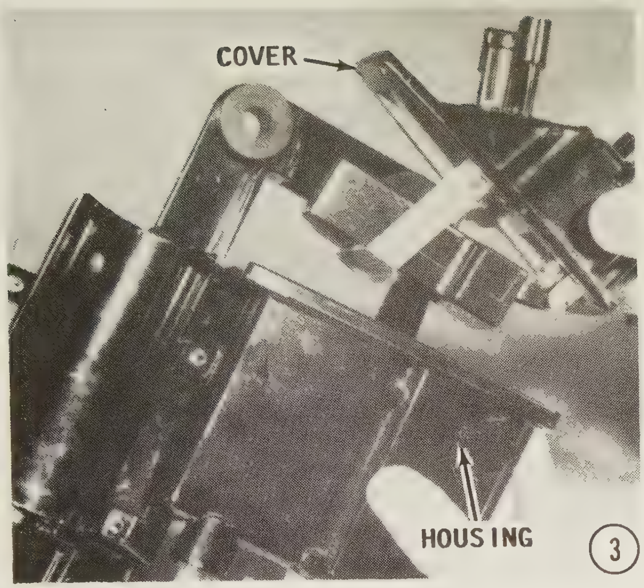
INSTALLATION

1- Install the O-ring around the housing.

2- Hang the inlet needle on the brass float tab. Lower the needle and float into place between the mounting posts, with the needle entering the seat. Insert the float hinge pin through the mounting posts.

3- Lower the cover assembly down into the housing. Install and tighten the six Phillips head screws with captive lockwashers.



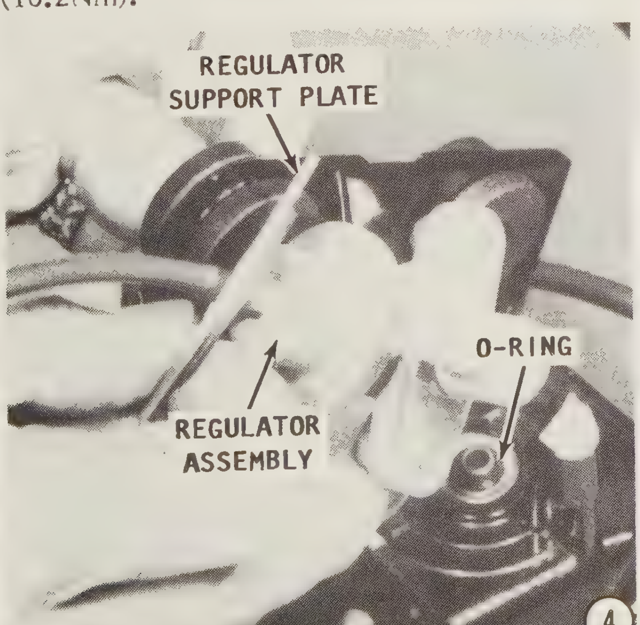


4- Position the O-ring around the regulator seat on the vapor separator cover. Install an O-ring in the regulator port, and then install the manifold plate to the regulator using the two Phillips head screws with captive lockwashers.

Position the regulator onto the vapor separator cover and slide the regulator support plate over the vacuum hose fitting.

5- Install and tighten the two Phillips head screws with captive lockwashers through the support plate and into the vapor separator cover.

6- Position the assembled vapor separator and fuel pressure regulator up against the powerhead. Install and tighten the three attaching bolts to a torque value of 90 in lbs (10.2Nm).



Connect the two vacuum hoses, one from the crankcase bleed system and the other from the intake manifold, to the two fittings on the vapor separator cover. Observe that these hoses have two different size inner diameters to fit over the two different size fittings.

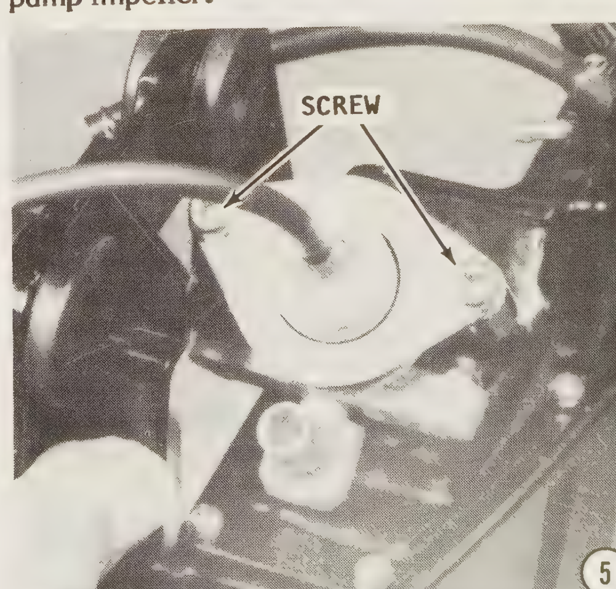
Connect the vacuum hose from the intake manifold to the fuel pressure regulator. Connect the fuel return hose between the vapor separator and the regulator. Connect the fuel filter outlet hose between the secondary fuel filter and the fitting on the intake manifold. Position the rubber blanket and electric fuel pump in place on the powerhead. Connect the inlet and outlet hoses to the pump. Install the cover plate and secure it in place with the four mounting bolts. Connect the **Red** and **Red/Purple** leads to the correct terminals on the electric fuel pump, as shown in the accompanying illustration. Connect the fuel line between the base of the vapor separator and the electric fuel pump. Remove the plug from the oil inlet hose and connect the hose to the fitting at the base of the vapor separator.

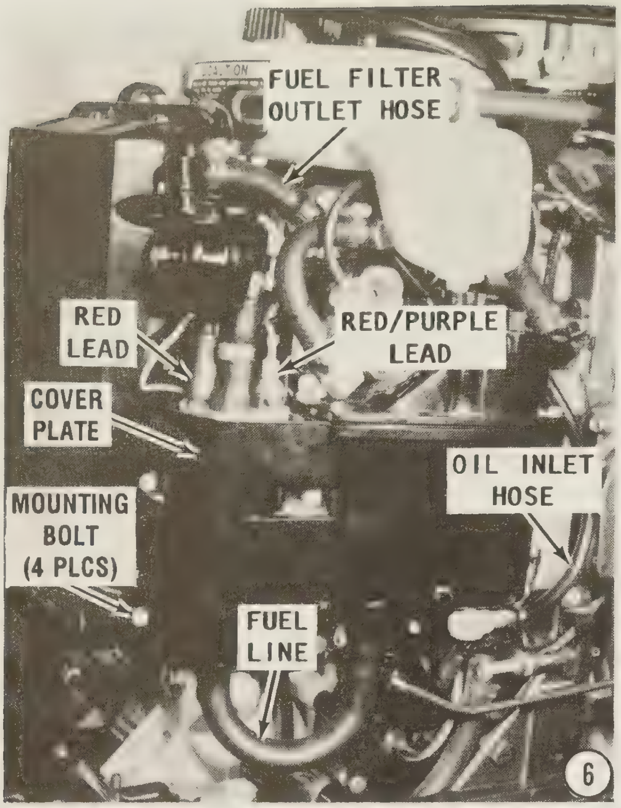
7- Remove the plug from the fuel inlet hose and connect the hose to the fitting at the top of the vapor separator cover.

Make a quick check of all connections made in the last two steps.

CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

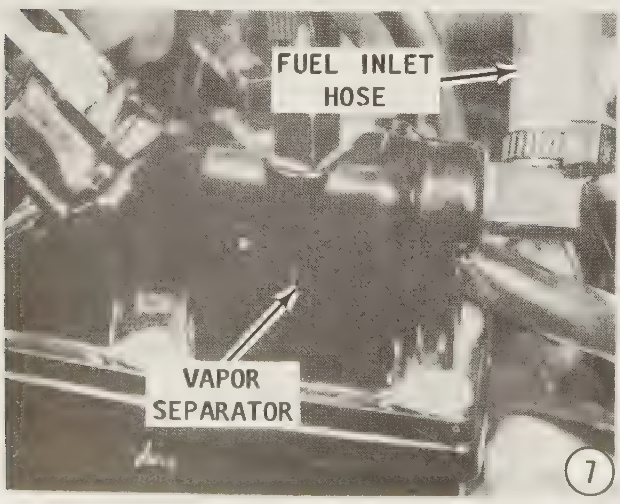




Start the powerhead and check for fuel leaks.

CRITICAL WORDS

The system will be pressurized as soon as the powerhead is cranked. Watch for leaks around all fuel hose connections which were disturbed. Because the system is pressurized, a leak will not appear as drips. Instead fuel will **SPRAY** all over the powerhead. Should this occur, shut down the powerhead immediately. **DO NOT** forget to **DEPRESSURIZE** the system at the pressure port on the intake manifold before making necessary repairs.



THROTTLE SENSOR SERVICE

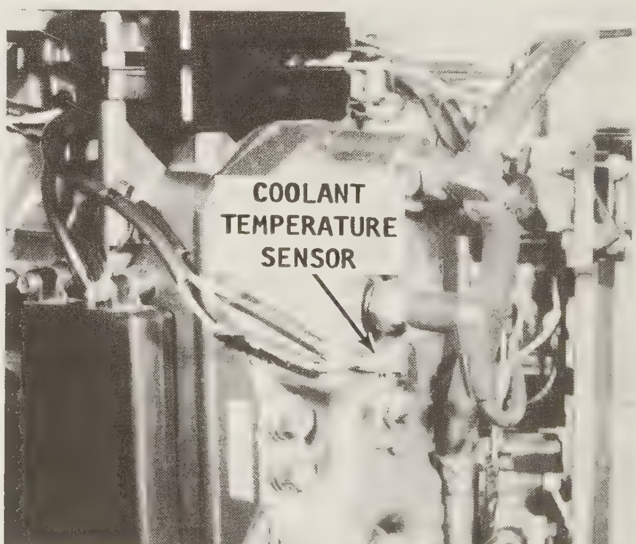
Mark the original location of the throttle position sensor **BEFORE** removal. If this sensor is misaligned during installation, a **DIGITAL** type voltmeter is needed to correctly reset the sensor on its mounting bracket. During alignment, voltages must be accurately measured to within 1/10 volt. A misaligned sensor could send misleading signals to the ECU and consequently affect the EFI and the ignition timing.

After marking the position of the throttle sensor, remove the two securing screws and lift the sensor free from the throttle shaft.

To install a new sensor, check to be sure the throttle position sensor shaft engages the slot on the throttle shaft. Secure the sensor with the attaching hardware, in **EXACTLY** the same location as before removal. The marks made during removal should be aligned. If no locating marks were made during removal, **CAREFULLY** examine the bracket for traces of an outline of the sensor and attempt to mount the sensor as near to the original location as possible. A difference of 0.04" (1mm) corresponds to 2^{o} throttle angle.

Throttle position sensor adjustment is covered in the following paragraphs using a **DIGITAL** type voltmeter.

Do **NOT** attempt this adjustment unless an instrument is available capable of indicating voltage accurately to within 1/10 volt. If such an instrument is not available, it is strongly recommended qualified techni-



*The EFI coolant temperature sensor, located in the port cylinder head, **MUST** be grounded while the throttle position sensor is being adjusted.*

cians at the local Mariner dealership install and calibrate this sensor using the necessary equipment.

Throttle Position Sensor Adjustment

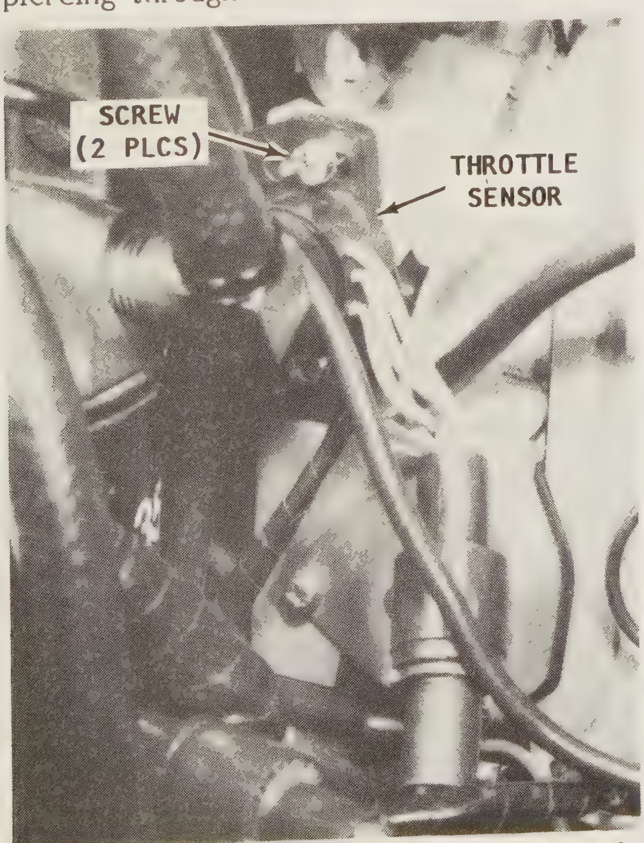
This adjustment is performed with the powerhead **NOT** running.

Loosen the screw next to the cam follower to allow the follower to ride freely along the throttle cam. On V6 powerheads with EFI and equipped with an idle speed screw, back off the idle speed screw, located just above the cam follower, from the stop on the intake manifold. The throttle position sensor **MUST** be adjusted with the throttle plates fully closed and with the arm of the throttle shaft against the throttle valve stop screw.

Disconnect the two Tan/Black leads from the powerhead coolant temperature sensor at their quick disconnect fittings. This sensor is located in the port cylinder head.

SPECIAL METER

The meter used in this test must have either a special harness for measuring the output voltage or have probes capable of piercing through the insulation of the wires



*The throttle position sensor **CANNOT** be accurately adjusted without the use of a digital type voltmeter.*

to make contact without disconnecting the leads or damaging the insulation of the leads.

Select the Vx1 scale on the voltmeter. Ensure the two mounting screws of the sensor are snug enough to permit the sensor to be rotated a few degrees either way and still hold its position.

Make contact with the Red voltmeter lead to the Orange sensor lead. Make contact with the Black voltmeter lead to the Tan/Black sensor lead.

Turn the key to the **ON** position **WITHOUT** starting the powerhead. Begin by rotating the sensor **CLOCKWISE** as far as possible. Note the meter reading. Now, rotate the sensor **COUNTERCLOCKWISE** until the meter reading increases by 0.01 to 0.02 volts from the original reading. At this point, tighten both securing screws to a torque value of 23 in lb (2.5Nm) to hold the adjustment.

A misalignment of the sensor by 0.04" (1mm) on the mounting bracket corresponds to 2° of throttle angle.

With the voltmeter still connected, open and close the throttle valve a few times to be sure the output voltage fluctuates with different throttle angles. Also, check to see if the voltage reverts back to the specified level when the throttle valves are fully closed.

MARK the position of the new sensor in relation to the bracket as a preparation for possible future service.

Connect the two Tan/Black leads from the powerhead coolant temperature sensor at their quick connect fittings.

See Chapter 6, Section 6-6 for adjustment of the throttle cam and idle speed screw which were disturbed while making this adjustment.

FINAL WORDS

The operation of this sensor can be compared to the volume knob on a radio. If the listener has a favorite position for the knob, in time a "flat spot" will wear on the shaft and interference may result.

If the operator of the outboard has a favorite throttle position, in time a "flat spot" will wear on the sensor shaft and not provide the ECU with accurate information. This condition could lead to ignition timing which varies by as much as 20° with no change in throttle position and incorrect operation of the EFI.

4-12 OIL INJECTION

INTRODUCTION

Oil injection systems replace the age old method of manually mixing oil with the fuel for lubrications of internal moving parts in the powerhead.

Since outboard units have grown in number of cylinders with accompanying increases in horsepower, and because the size of the fuel tanks also grew to handle the increased demand of these larger powerheads, the requirement for a more sophisticated method of mixing oil with the fuel for internal lubrication became a primary design objective.

Almost all outboard manufacturers have now developed their own method to provide adequate oil delivery to the cylinders under all demands of the powerhead. Each system has its own trade name.

ADVANCED OIL INJECTION

Since the mid 1980's a new oil injection system has been installed on the larger V6 powerheads. The mechanically driven oil pump and oil reservoir is now mounted on the powerhead. The pump is driven by a worm gear directly off the crankshaft. Oil from the pump is pumped just a short distance to the fuel inlet line, prior to entering the fuel pump. The oil/fuel mixture is then routed through an in-line filter to the carburetors or to the vapor separator on powerheads with electronic fuel injection.

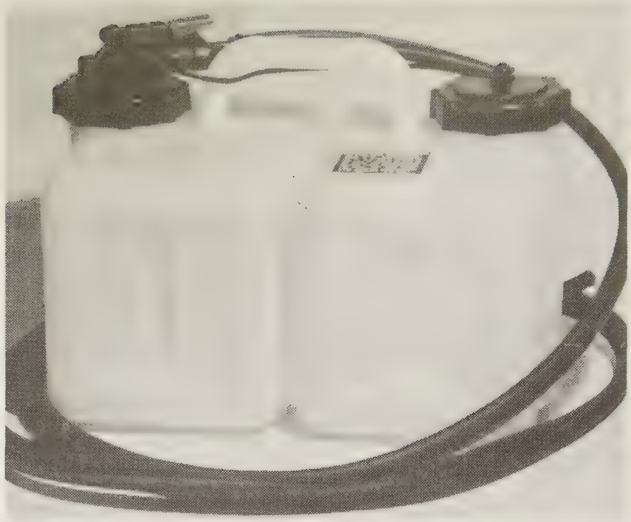
DESCRIPTION

Since the introduction of the "Auto Blend" oil injection system in the mid 1970's. The engineers have strived to improve delivery of the oil/fuel mixture to the carburetors. The results of these efforts was the introduction of a new improved system, we have labeled "Advanced Oil Injection".

As explained in the following paragraphs, the oil reservoir and pump which used to be mounted in the boat, has now been moved to the powerhead. The oil pump flow rate is variable with powerhead throttle changes.

Components

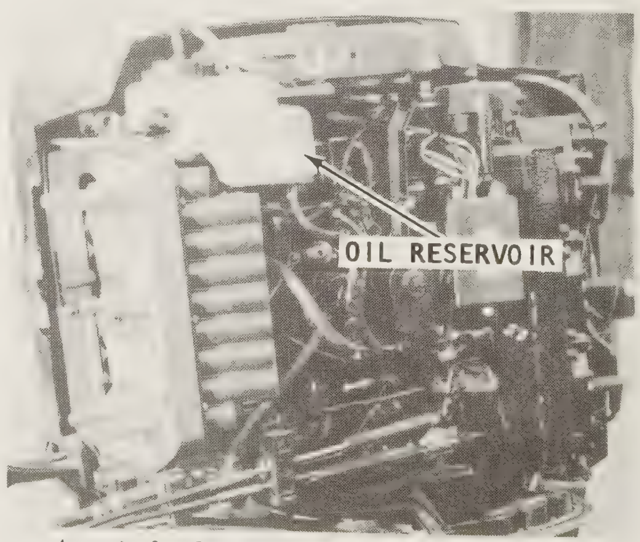
The system consists of a remote oil tank, an oil reservoir, an oil injection pump, three check valves, two sensors, a warning module, a warning horn, and the necessary electrical and hose connections for the system to operate properly. The accompanying functional diagram on the next page, will be most helpful in understanding how the system delivers the correct amount of oil/fuel mixture to the carburetors.



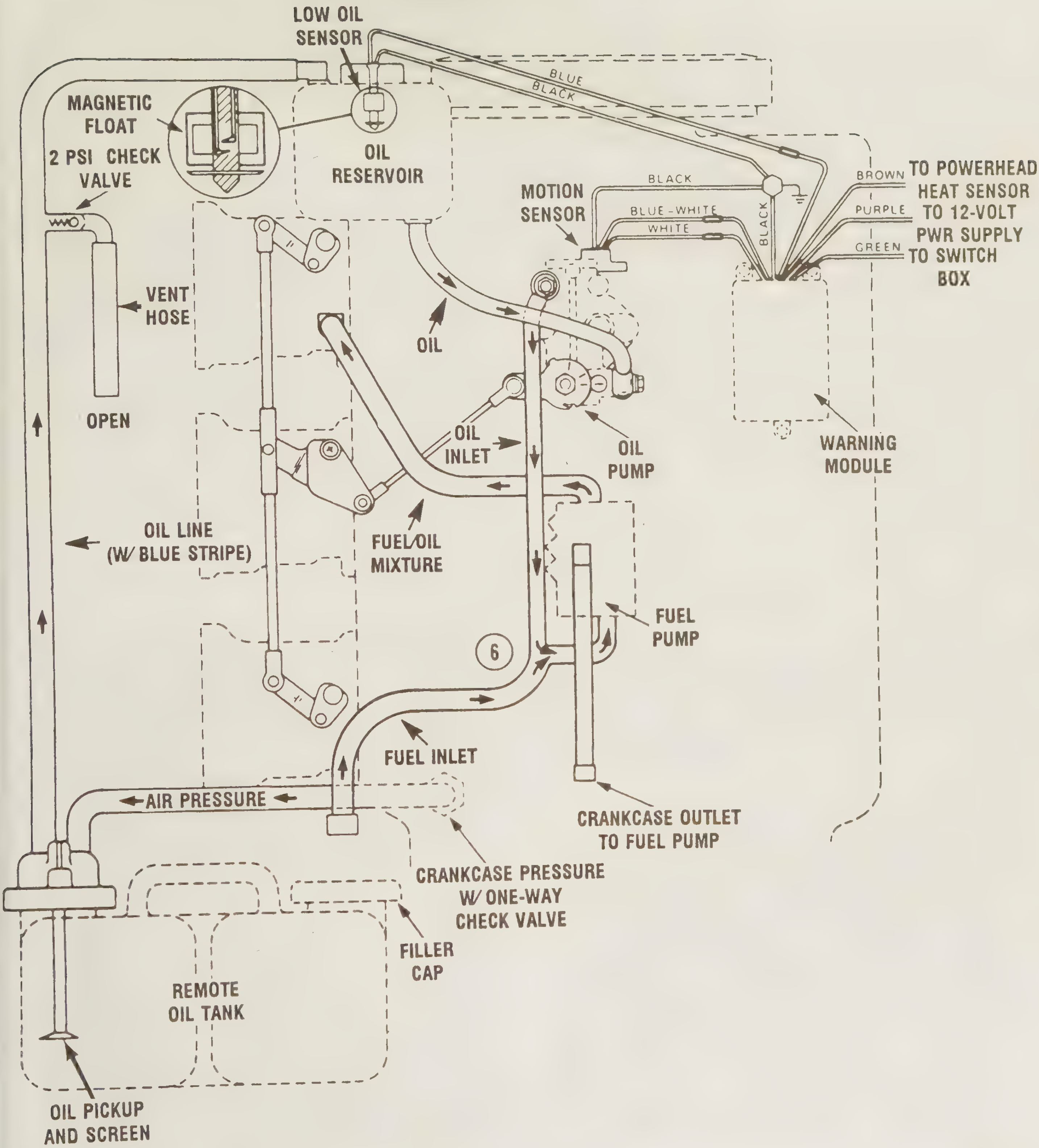
Remote oil tank for the oil injection system ready for installation in the stern of the boat.

Remote Oil Tank

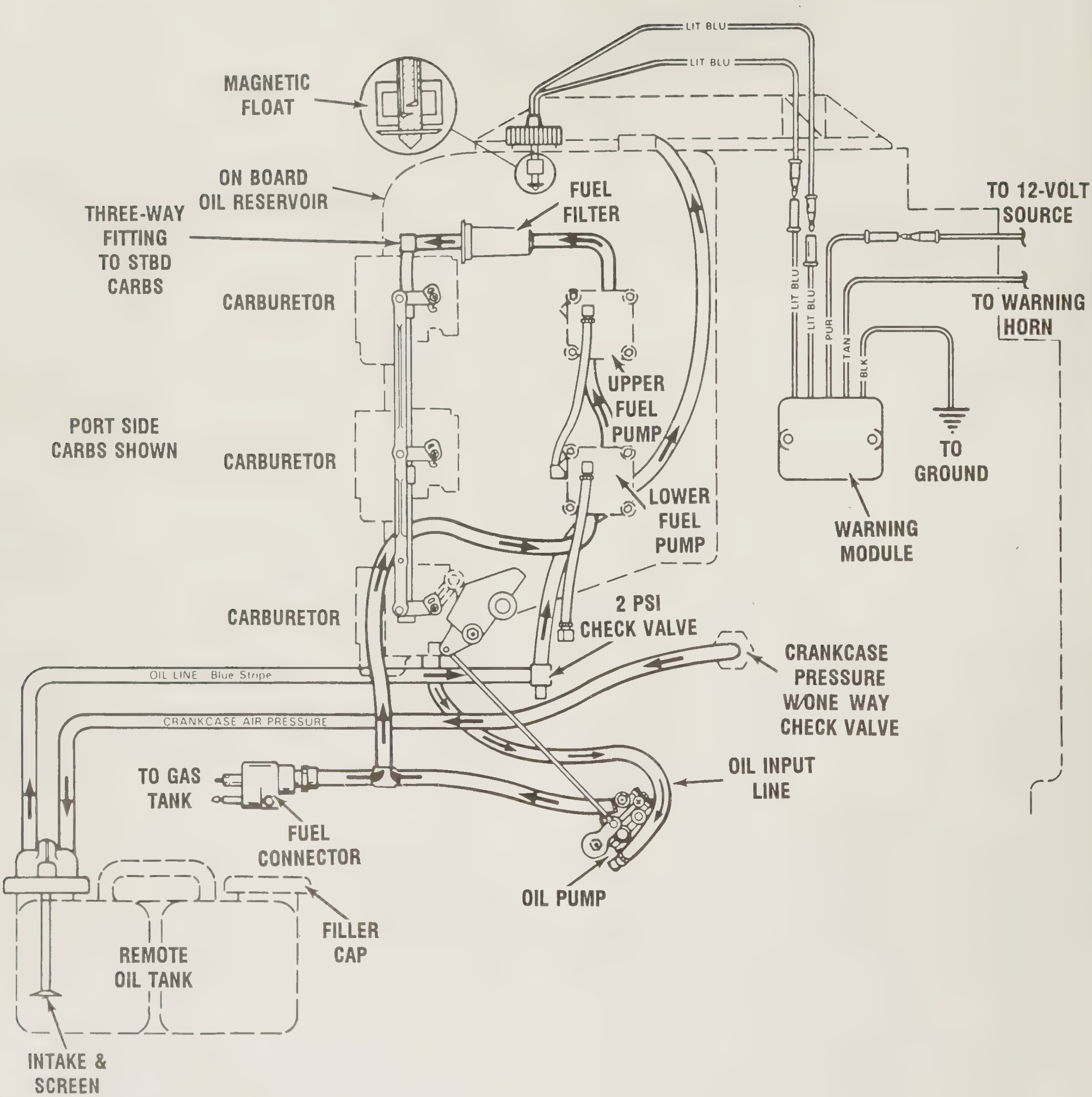
The remote oil tank has a capacity of 3 gallons US (11.4L). This amount will provide enough oil to mix with 150 gallons (about 568L) with the powerhead operating at wide open throttle (WOT). The tank should be positioned in the boat as close to the outboard unit as possible and secured to keep it upright and prevent spillage. The tank is pressurized while the powerhead is operating. Therefore, the restraints used with



A typical oil reservoir installation on top of the powerhead providing gravity flow to the oil pump.



Functional flow diagram of the oil injection system installed on the Model 135 thru 225hp powerhead.



Functional flow diagram of the oil injection system installed on the Model 275hp powerhead equipped with dual (upper and lower), fuel pumps.

the tank should be left with a small amount of slack to enable the tank to expand slightly when it is under pressure.

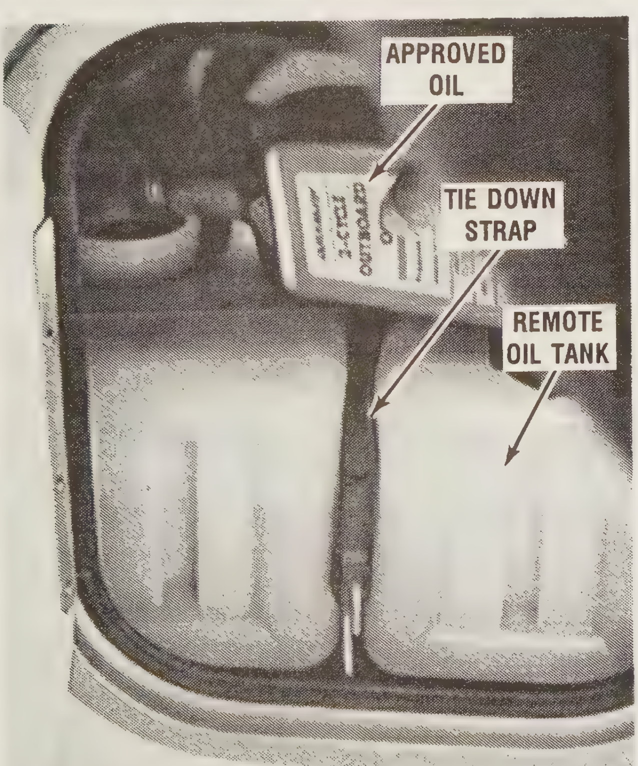
Another factor to be considered when placing the remote tank in the boat, is easy access for unlatching the quick disconnect fitting and removal of the tank for filling. However, it is not necessary to remove the tank for filling.

Oil Reservoir

The oil reservoir is much smaller than the remote tank and is attached to the powerhead under the cowling. The reservoir will only hold enough oil to mix with the fuel for about 30 minutes of powerhead operation at WOT, after the remote tank is drained. The prudent boat owner will consider the reservoir capacity as an emergency ration and will not rely on using it after the remote tank is empty.

Low Oil Sensor

The low oil sensor is installed in the top of the oil reservoir. This sensor operates on a magnetic float principle. As the oil level drops to the dangerous level, a circuit is closed and the warning horn will sound.



Adding oil to a typical remote oil tank installation in the stern of the boat under a seat against the transom.

Oil Pump

The oil pump is mounted on the powerhead and is driven by a gear and shaft arrangement off the crankshaft. Therefore, as soon as the crankshaft begin to rotate, even during the cranking process, the pump also rotates and begins to deliver oil to the fuel line through a "T" fitting just prior to the fuel pump. The pump will meter oil for a mixture with the fuel of approximately 50:1 at WOT, and changes to a ratio of 100:1 at idle speed.

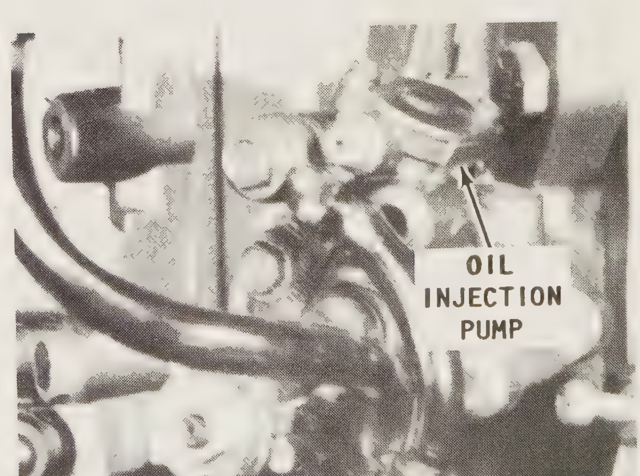
Motion Sensor

The motion sensor is considered a part of the oil pump. If the pump drive system fails to operate for any reason, the sensor will signal the warning module and the warning horn will sound.

Check Valves

Three check valves are used in the system. One 2 psi valve is connected to a Tee fitting in the oil line from the remote tank to the oil reservoir. The third side of the Tee fitting is vented to atmosphere. This check valve prevents pressure in the tanks and the lines from increasing above 2 psi.

The second check valve is also rated at 2 psi and is installed in the oil line just before it enters the fuel/oil mixer. This



The oil injection pump is driven off the crankshaft and supplies oil to the fuel pump. The oil pump is gravity fed from the oil tank mounted high on the powerhead.

second valve prevents fuel from entering the oil system behind the fuel/oil mixer.

A third check valve is located in the pressure hose from the powerhead crankcase to the remote tank. This valve allows pressure to pass in only one direction.

Warning Module

The warning module is connected electrically to the low oil sensor in the oil reservoir; to the motion sensor of the oil pump; to the powerhead heat sensor in the powerhead; to the switch in the remote control box; and to a 12-volt supply.

The module responds to signals from all three sensors and completes the circuit to the warning horn. By having the module connected to the ignition switch, each time the switch is turned on and before the powerhead starts, the warning horn will sound because the motion sensor sends a signal to the module indicating the pump is not operating. The horn sounding also assures the boat operator the system is functioning properly.

OPERATION ADVANCED OIL INJECTION

When the key switch on the remote control box is turned to the **ON** position, the warning horn will sound intermittently, indicating the warning horn circuit is functioning.

Once the powerhead begins to operate, pressure from the crankcase passes through the one way check valve, through a connecting hose, through a fitting on top of the remote oil tank, and pressurizes the remote tank to 2 psi.

After the tank is pressurized, oil enters the pickup tube extending down into the tank from a cap on the tank top. A screen at the bottom of the pickup tube filters out foreign matter in the oil.

From the pickup tube, the oil passes upward through the oil hose with a blue stripe into the oil reservoir mounted on the powerhead.

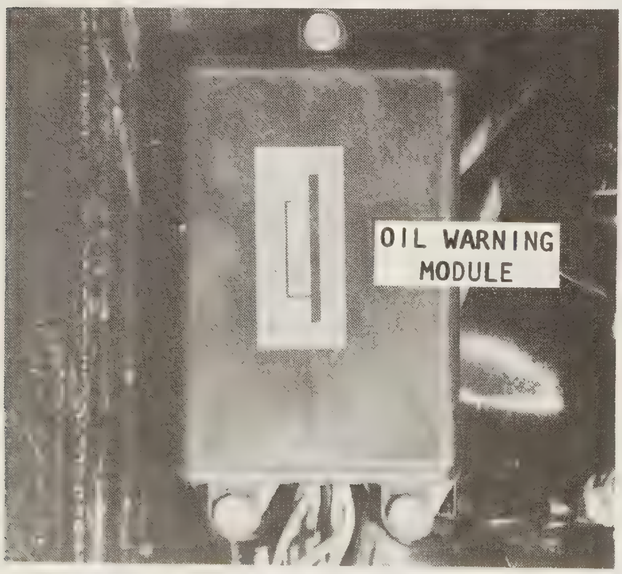
From the reservoir, the oil is gravity fed downward to the oil injection pump.

Because the oil injection pump is mechanically operated through a gear and shaft from the crankshaft, as soon as the crankshaft begins to rotate, even during cranking, the pump begins to rotate also.

The injection pump will meter oil at an oil/fuel ratio of approximately 100:1 at idle speed and at 50:1 ratio at WOT.

This metering is controlled through direct linkage to the carburetor linkage.

From the oil injection pump, the oil is mixed with fuel just prior to the fuel pump and transferred to the top carburetor.



The oil warning module is clearly marked and is installed on the port side of the powerhead.

At the first sign of trouble -- the oil warning horn sounding intermittently -- shut down the powerhead at once and check the supply of oil in the reservoir.

FILLING OIL INJECTION SYSTEM

There is nothing mysterious or difficult about working with the oil injection system. A few points need to be mentioned to ensure proper performance of the system.

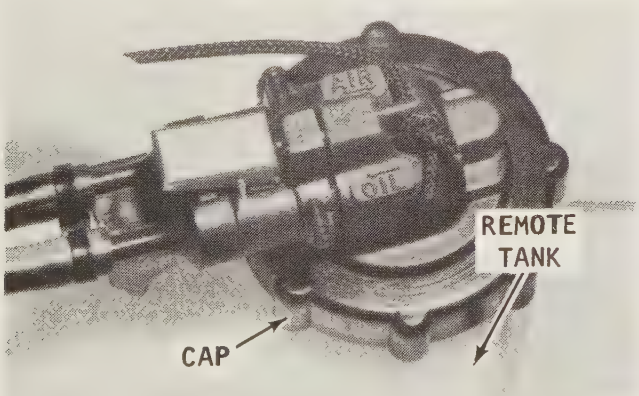
To fill the remote tank, first remove the filler cap from the top of the tank. If the tank is pressurized, a small amount of air will emit an audible sound as the air escapes when the cap is "cracked" open.

Next, fill the tank to the 3-gallon mark with oil. Do not fill the tank past the mark because space must be left to pressurize the tank from the powerhead crankcase. The manufacturer recommends Quicksilver Formula 2-cycle Outboard Motor Oil. If this oil is not available in your area, a high quality 2-cycle outboard oil with an NMMA rating of TCW may be substituted.

After the tank is filled to the proper level, install the gasket and then tighten the fill cap securely. An air leak at the remote oil tank cap will allow crankcase pressure to escape and prevent the tank from being pressurized to the required 2 psi. Adequate pressure in the tank will prevent sufficient oil from reaching the oil reservoir on the powerhead.

Check the oil level in the reservoir. If the powerhead has been operated and the remote tank filled, before it was empty, the reservoir should still contain an adequate quantity of oil.

If necessary, remove the fill cap and add oil as required. Be sure to install the gasket and tighten the cap securely. Now, open the cap 1/2 turn. Operate the powerhead and observe trapped air being bled off from the reservoir fill cap. Once air has been purged from the hose between the remote tank and the reservoir, and from the reservoir, only oil will be discharged from around the cap. At this point, tighten the cap securely and observe -- no oil leak from the cap.



The "air in" and "oil out" fittings of the remote tank cap are embossed for identification. The powerhead supplies the air.

An air leak at the reservoir fill cap will cause oil to escape and a reduction in efficiency of the system.

Take time to check the routing of the pressure and oil hoses to and from the remote tank to ensure they do not contain any sharp bends, kinks, or have an object on them to restrict the flow of oil.

PURGING AIR (BLEEDING) ADVANCED OIL INJECTION SYSTEM

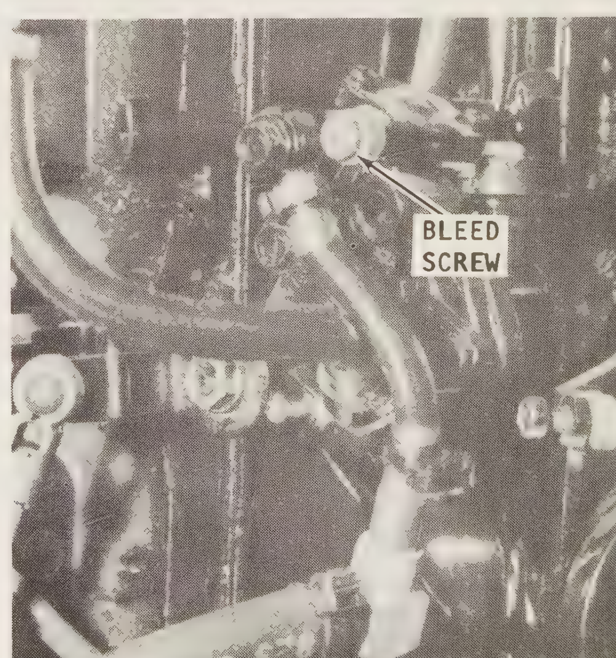
Air must be purged ("bled") from two areas of the system to ensure the proper amount of oil being delivered to the cylinders, either through the carburetors or the EFI system.

Bleed Air From Reservoir and Inlet Hose

With the powerhead operating at idle speed, "crack" the reservoir fill cap open about 1/2 turn. Air will escape from the cap. When the hose between the remote tank and the reservoir has been purged, and the reservoir purged, only oil will escape. Tighten the cap securely.

Bleed Air From Pump and Outlet Hose

With the powerhead not operating, hold an absorbent cloth below the oil injection



The oil pump bleed screw is located on the port side and is easily accessible.

pump and be prepared to catch oil as it oozes from the bleed screw. Loosen the bleed screw three, maybe four full turns, and allow oil and any air to escape from the screw. When a steady stream of oil is observed with no sign of air, tighten the screw securely.

OIL PUMP ADJUSTMENT

Because the oil injection pump meters oil to mix with fuel for delivery to the carburetors or the EFI system, the pump is physically connected through linkage to the throttle shaft linkage. This arrangement ensures a change in oil metering as the throttle is opened and closed.

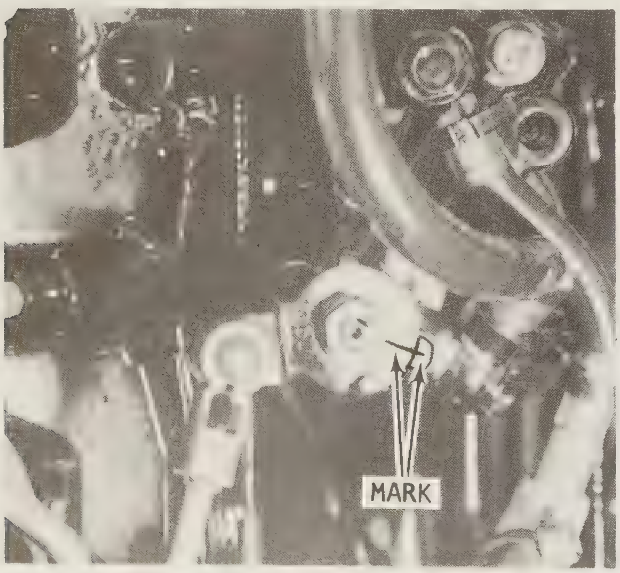
To adjust the oil injection pump, begin with the throttle linkage in the idle position and the powerhead **NOT** operating. Observe the mark on the oil injection arm and the mark on the pump casting. The two marks should be aligned.

If the marks are not aligned, adjust the oil injection link rod as shown in the accompanying illustration.

TROUBLESHOOTING OIL ADVANCED INJECTION SYSTEM

The first indication of a problem in the oil injection system will be indicated by the warning horn sounding intermittently. If the horn sounds while the powerhead is operating, shut the unit down **IMMEDIATELY.**

Open the cowling and make a visual inspection of the oil injection components.



To adjust the oil pump, align the two marks according to the procedures outlined in the text.

If the oil level in the reservoir is low, the horn was correct in sounding. Filling the reservoir with oil will **NOT** correct the problem. A determination must be made as to why the oil level is low.

Check the oil level in the remote tank. Add oil as required to bring the level up to the 3-gallon level mark. Inspect the oil hose with the blue stripe to be sure a piece of gear has not accidently been placed on the hose restricting oil flow to the reservoir.

WARNING
NEVER OPERATE THE POWERHEAD ON FUEL ONLY. IN AN EMERGENCY, ADD OIL FROM THE REMOTE TANK TO THE FUEL TANK. SERVICE THE OIL SYSTEM AT THE FIRST OPPORTUNITY.

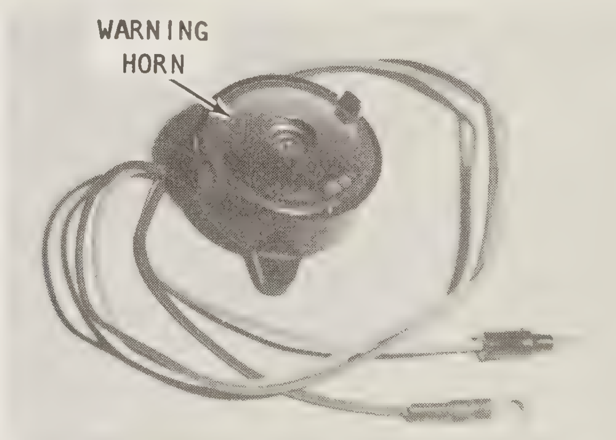
Consult the **TROUBLESHOOTING** chart in this section for possible causes and corrective action to be taken to return the oil injection system to satisfactory operation.

SERVICING ADVANCED OIL INJECTION

The following procedures provide detailed illustrated steps to service components of the "Advanced Oil Injection System".

Perform only the steps required to return the system to satisfactory operation.

Keep the work area as clean as possible and strive to prevent contaminants from entering the system. One of the filter screens in the fuel filter has extremely small openings and can become quickly clogged with dust particles or other foreign material.



The warning horn is usually located under the instrument control panel.

TROUBLESHOOTING

Oil Level In Reservoir Low But Adequate In Remote Tank

Possible Cause	Corrective Action
Remote tank fill cap is leaking air.	Ensure gasket is in place & cap is tight.
Remote tank quick disconnect not connected.	Ensure fitting is full connected.
Pickup screen clogged in remote tank.	Remove, clean, and replace screen.
Restriction in blue striped oil hose.	Check hose for kinks or obstruction.
Hose from reservoir to pump damaged.	Check for damage & replace, if required.
Hose between oil pump & fuel pump damaged.	Check for damage & replace, if required.
Check valve at fuel pump faulty.	Test & replace valve, if required.

Warning Horn Fails To Sound When Ignition Key Is Turned To ON

Possible Cause	Corrective Action
Faulty horn or open tan wire between horn and powerhead.	Disconnect tan lead from powerhead wiring harness at terminal block on powerhead. Ground tan lead to powerhead ground. Warning horn should sound. If not, check tan wire between horn and powerhead for open circuit. Check horn.
Warning module failure.	Ensure all warning module leads are connected to harness leads. If so, warning module is defective.

Horn Sounds Continuously When Ignition Key Is Turned To ON

Possible Cause	Corrective Action
Faulty powerhead overheat sensor.	Disconnect overheat sensor and turn ignition key to **ON** position. If horn still sounds continuously, warning module is at fault. Replace module and retest. If horn does not sound, overheat sensor is faulty. Replace. If horn sounds intermittently, warning module is faulty. Replace.

TROUBLESHOOTING

Warning Horn Sounds When Powerhead Is Operating Oil Level In Reservoir Adequate

Possible Cause	Corrective Action
Faulty powerhead ignition system.	Check ignition coil lead connections on ignition switch box. Determine the coil lead having the green wire from the warning module connected to it. Check the coil for correct voltage using the DVA. If voltage to coil is correct, voltage to warning module is correct.
Defective low oil sensor in reservoir.	Disconnect both low oil sensor leads from terminal connectors. Do not remove cap from reservoir. Connect ohmmeter between leads. Meter should indicate **NO** continuity. If continuity is present, sensor is faulty.
Defective motion sensor at oil pump.	**WARNING: TAKE STEPS TO PREVENT POWERHEAD START DURING FOLLOWING TESTS.** First, disconnect white lead from module. Check voltage from white lead. Voltage should be 12 volts plus or minus one volt. Next, connect white lead from module. Sensor leads must be connected to module for remaining tests. Insert probe into wire connection for voltage checks. Now, check output voltage to sensor by connecting voltmeter to Blue/White sensor lead. Remove spark plugs and ground spark plug leads. Turn ignition to **ON.** Use emergency start rope and rotate flywheel and at same time observe voltmeter. Output voltage should peak at 5 volts plus or minus one volt and then drop to less than 1 volt during every 2 revolutions of crankshaft. If **NO** voltage is present, then one of two conditions exists: Defective motion sensor -- replace sensor. Defective drive system -- test as described in next section.
Defective oil pump drive system.	**ENSURE** unit will have adequate cooling water. Use 50:1 fuel/oil mixture and start engine. Disconnect link rod between pump and carburetor linkage. Disconnect outlet hose of pump and observe if pump is discharging oil. If no oil, pump drive system is at fault.

GOOD WORDS

The only purpose for disassembling oil injection pump is to locate a problem in oil delivery. For example, if the pump is frozen due to debris or rust, the pump can be disassembled and cleaned.

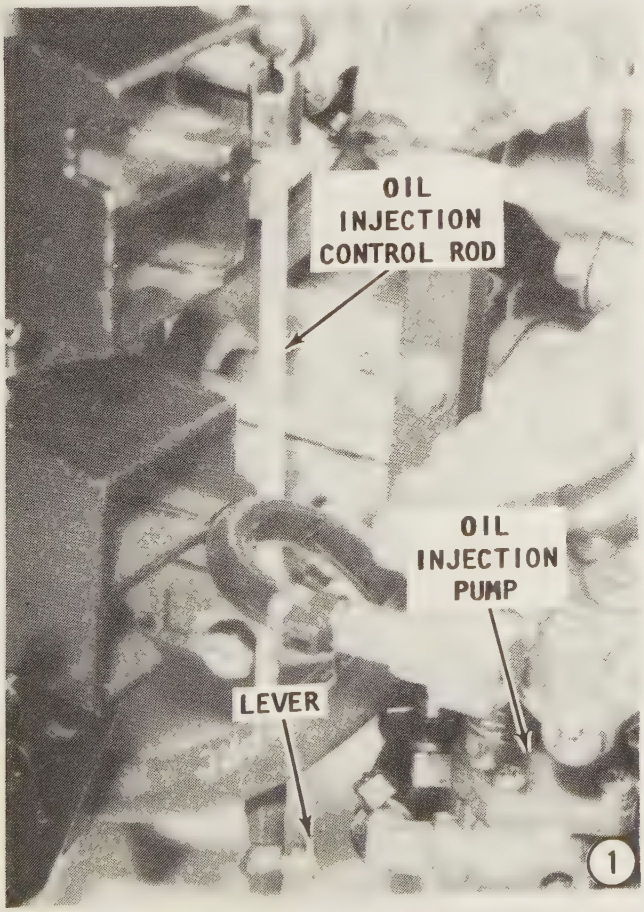
The manufacturer has made no provisions for rebuilding this pump. Spare parts are **NOT** available. If any part is found to be defective and no longer fit for service, other than O-rings, washers or possibly the spring, the pump must be replaced.

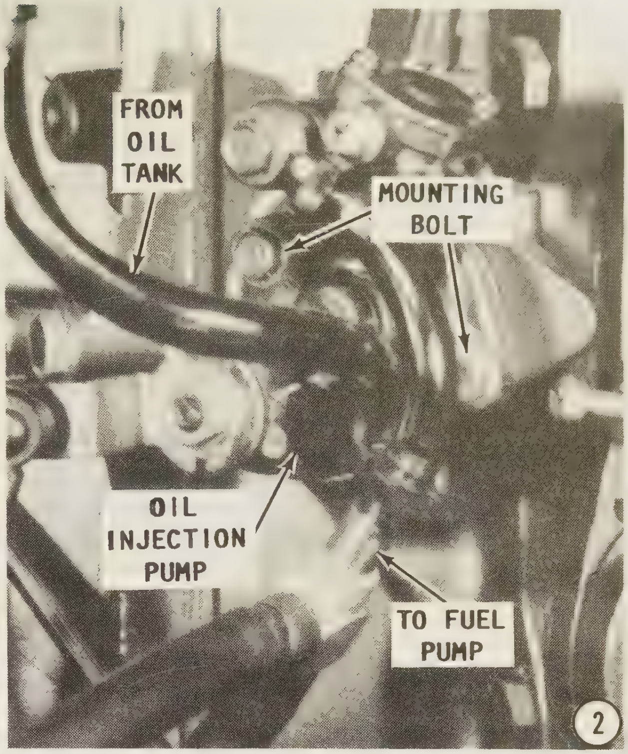
O-rings and washers can be matched and replaced, but the spring inside the pump is a component of the oil metering system. Therefore, the elasticity of the replacement spring must be evenly matched. Not an easy task.

SAVE the O-rings, even if they are defective. The old ring will be essential when purchasing a new ring to ensure the proper type and size is obtained.

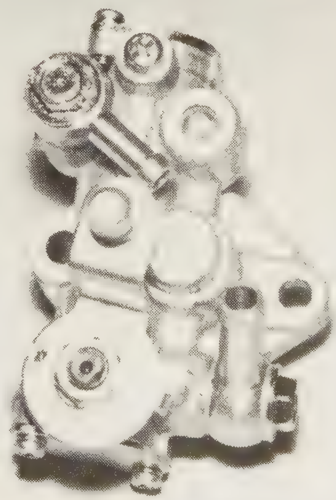
REMOVAL

1- Pry the oil injection link rod free of the ball joint on the injection pump lever. Take care not to alter the length of this rod. If the rod length is accidentally altered, procedures to adjust the length will be found on Page 4-86 -- Oil Pump Adjustment.

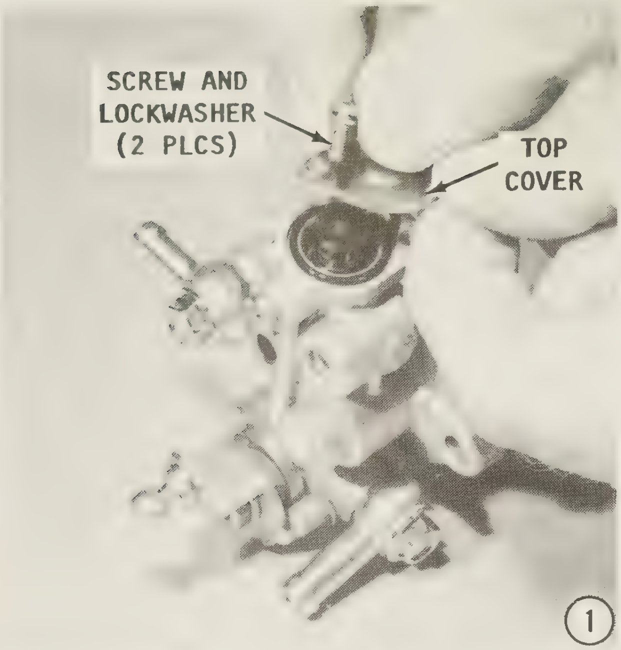




2- Position a suitable container as far as possible under the oil pump to receive oil drained from the tank. Snip the Sta-strap at the inlet fitting. Squeeze the oil supply line from the tank to the pump, to restrict the flow of oil while pulling it free of the fitting. Allow the contents of the tank to drain into the container. Pull the oil line free of the other oil pump fitting. Remove the two bolts securing the pump to the powerhead and lift the pump clear.



An oil injection pump removed from the powerhead ready for servicing.



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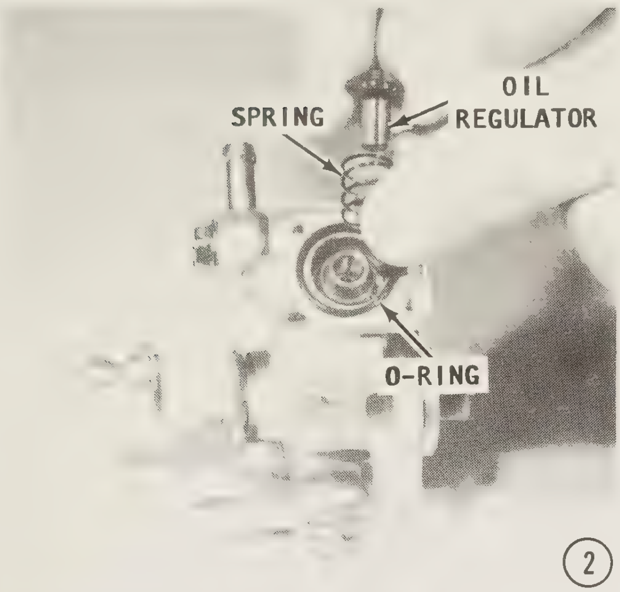

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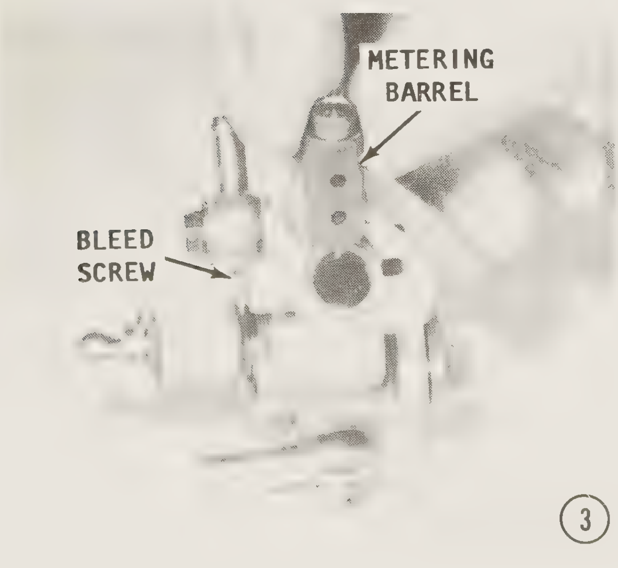

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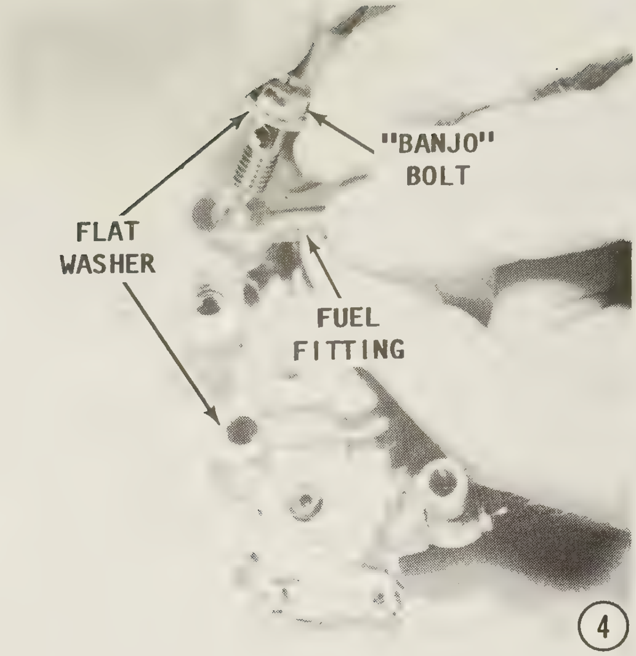

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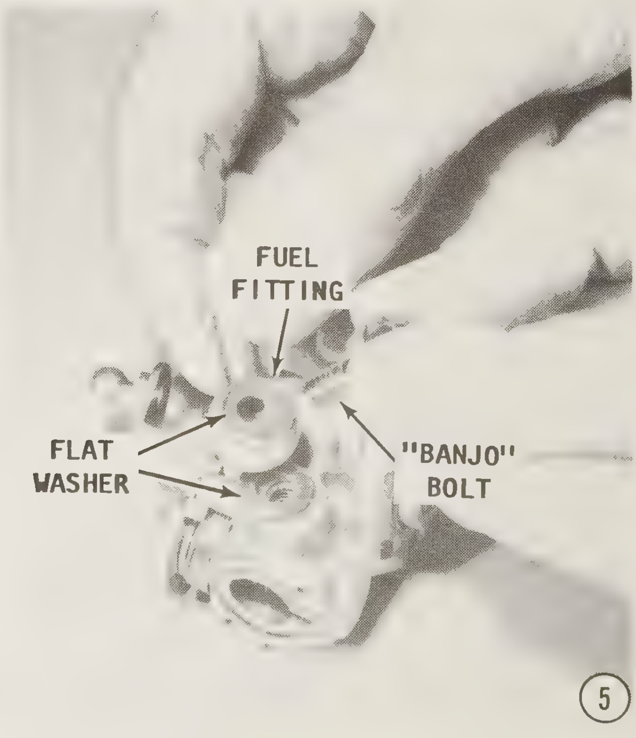
DISASSEMBLING

1- Remove the two Phillips head screws with captive lockwashers, and then remove the top cover.

2- Lift out the oil regulator and spring. Remove and save the O-ring.

3- Use a small pair of needle nose pliers and carefully pull out the metering barrel. Remove the bleed screw and gasket/washer.

4- Loosen and remove the "Banjo" bolt from the oil outlet fitting. The "Banjo" bolt is a very special bolt with a hole



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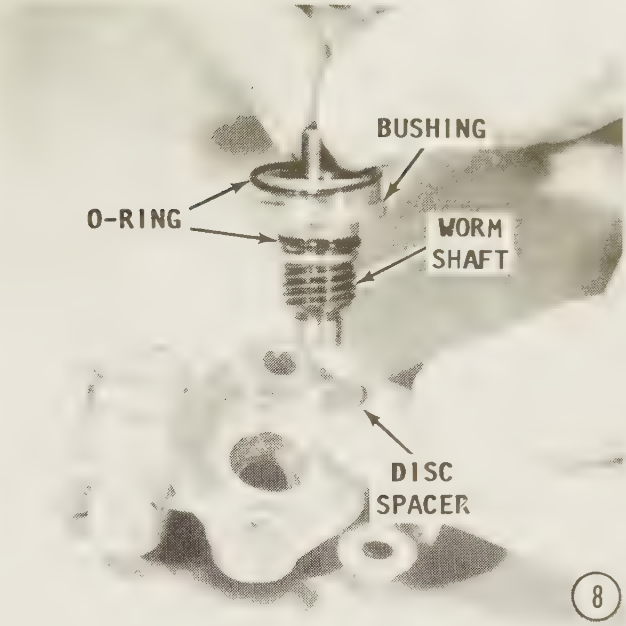

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through the shank. The design allows the bolt to be used to secure the fitting and at the same time permit oil to pass through.

Remove the fuel fitting and the two flat washers, one on both sides of the fitting.

5- Remove the fuel inlet fitting in the same manner, as described in the previous step.

6- Remove the two Phillips head screws with captive lockwashers, and then remove the bottom cover. Save the O-ring.

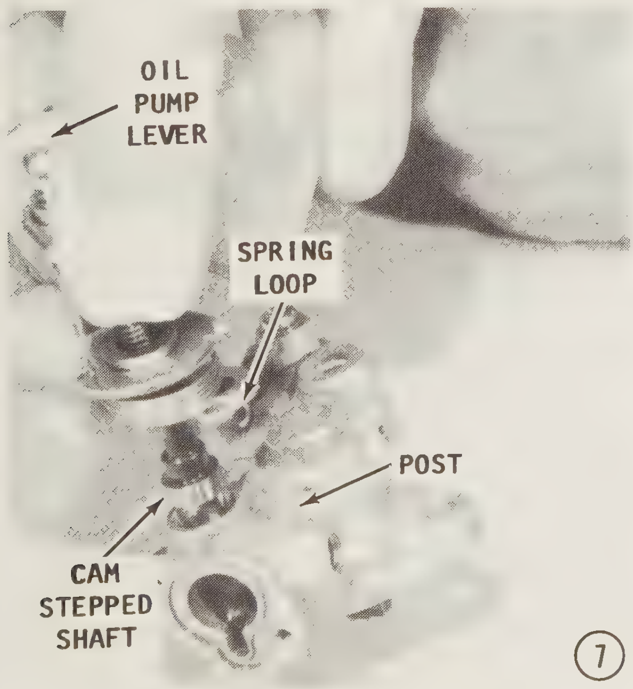
7- Note the spring tension on the lever provided by the spring, as an aid during installation. Unhook the small spring loop from the post on the pump body and pull out the oil pump lever and stepped cam shaft assembly. Save the O-ring.

8- Pull out the worm gear shaft and bushing from the side of the pump. Take care not to lose the small disc spacer at the end of the shaft. Save the two O-rings.

9- Push out the driven cam from the pump.

CLEANING AND INSPECTING

Make certain all O-rings are removed from the body before emersing the pump in solvent as the solvent will cause the rubber to swell and ruin the sealing properties of the O-rings.



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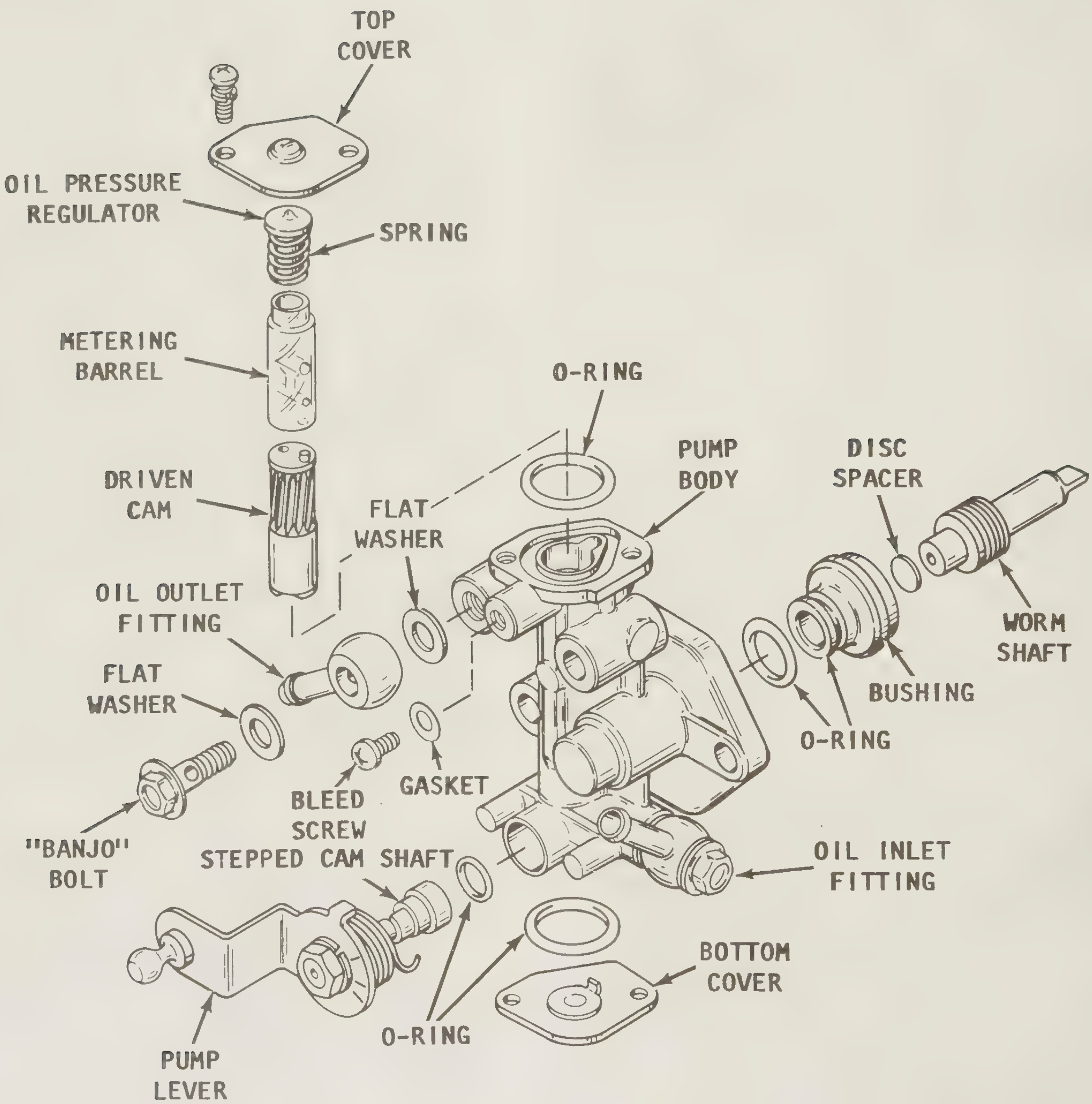


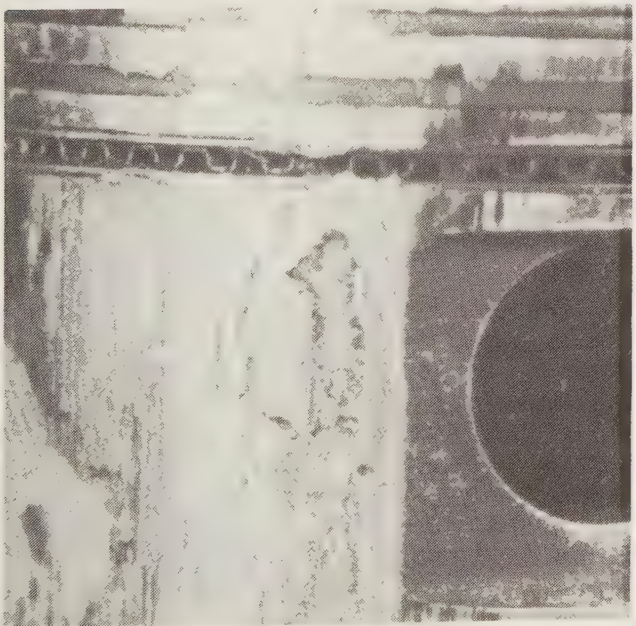
Exploded drawing of the oil injection pump installed on the powerheads covered in this manual. Major parts have been identified.

Rinse the pump body and pump covers in solvent and then blow them dry with compressed air. Check all parts and passages to be sure they are not clogged or contain any deposits.

Inspect the condition of the worm shaft threads/teeth and also those on the driven cam for excessive wear or cross threading. Inspect the two coupling posts on the driven gear which engage the holes in the metering barrel. If these posts are sheared off, or the holes elongated, the amount of oil delivered to the powerhead will be greatly restricted. Such a condition will cause a serious lack of lubrication in the powerhead. Therefore, the pump **MUST** be replaced.

The metering barrel and the driven cam ride on the stepped cam at the base of the pump. The regulator rides inside the top of the metering barrel. The top of the regulator rests against the top cover. As the stepped cam is rotated, by action of the oil pump injection lever, the metering barrel and driven cam are raised up against the spring pressure of the regulator spring.

As the metering barrel rises, relative to the regulator, small oil passages are blocked off. Thus, the action of the oil injection pump lever, regulates the oil flow at the outlet fitting. At low rpm, the metering barrel and driven cam ride on the high point of the stepped cam, restricting the flow of oil. At high rpm, the metering barrel, coupled with the driven cam, ride on the low side of the stepped cam shaft. In this position, the regulator is completely clear of the passages in the metering barrel and maximum oil flow is obtained. Any obstruction in these passages will restrict oil flow and subsequently powerhead lubrication.



The rings of this automotive piston became stuck due to lack of adequate lubrication, incorrect timing, or overheating. Same thing could happen with a powerhead.

If the oil pump had a tendency to leak oil, a number of areas may be at fault. The first place, and most common, is the O-ring around the worm shaft. If this O-ring was distorted during installation, the pump would leak at this point.

The second place for leakage is the top and bottom pump covers. Missing or distorted O-rings will cause the pump to leak at the covers.

The third place for leakage is the inlet and outlet fittings on the pump. These fittings **MUST** have a flat washer on both sides of the fitting. If either washer is missing, an oil leak could develop at this point.

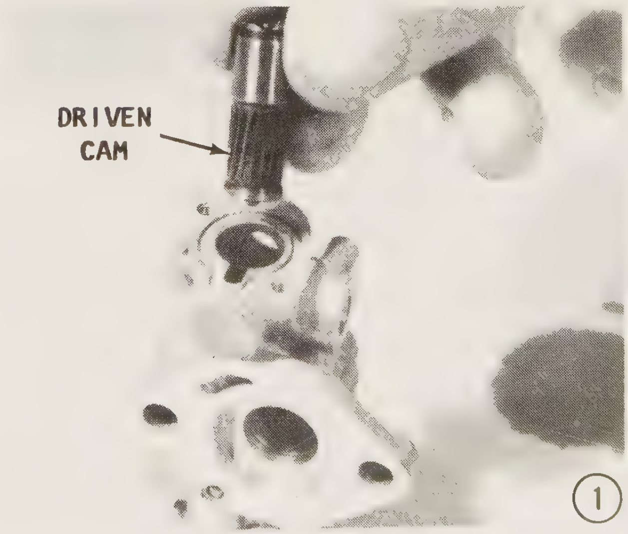
The fourth and last place for a leak is the gasket/washer under the bleed screw. Both of these items **MUST** be in place and in good condition.

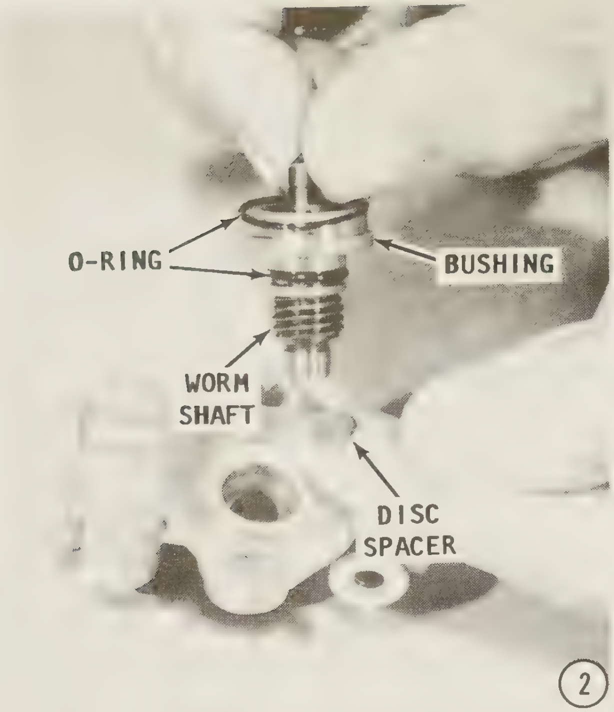
Inspect the holes in the two "Banjo" bolts. These special type bolts **MUST** be used to secure the fittings. Obviously, a regular solid type bolt will fit, but will totally shut off the flow of oil through the fitting, with **DISASTEROUS** results to the powerhead.

Lightly oil all internal pump components before assembling.

ASSEMBLING

1- Slide the driven cam down into the bottom of the pump body, with the gear end





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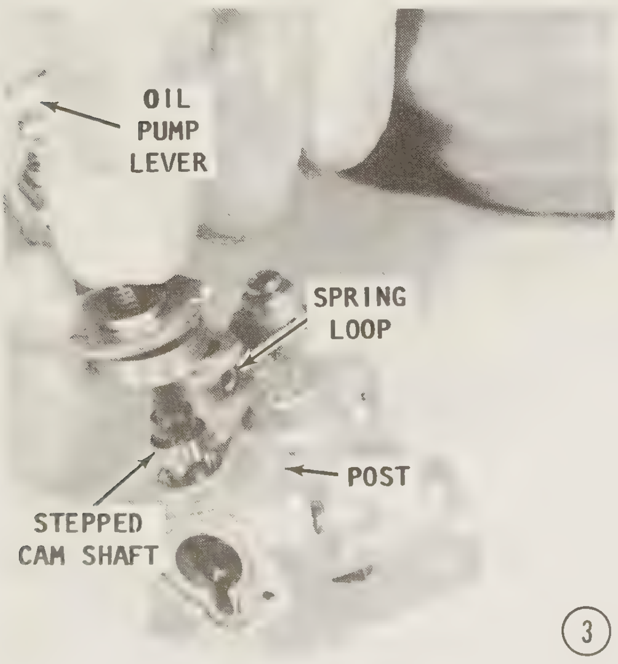
going in first. Line up the gear portion of the cam with the opening for the worm gear.

2- If the worm shaft was removed from the large bushing, slide the shaft back into place inside the bushing. Install the two O-rings around the bushing. Place the small disc spacer at the end of the worm shaft. Slide the assembled worm shaft into the pump with the teeth on the shaft indexing with the teeth on the driven cam. Push the shaft in until the shoulder of the bushing seats against the pump body.



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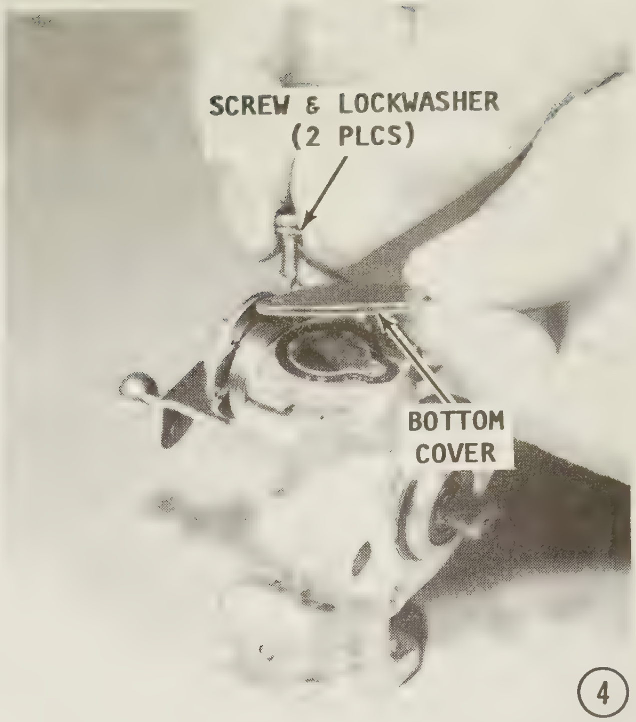

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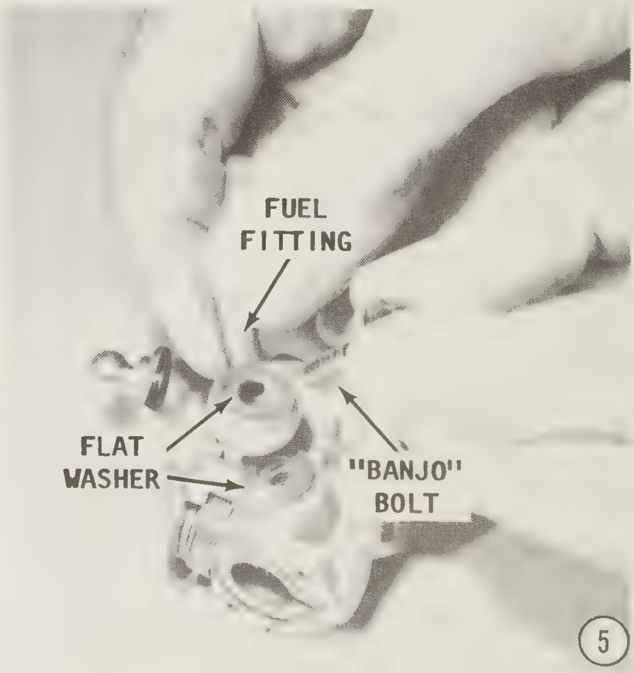
3- Install the O-ring around the stepped cam shaft. Slide the oil pump lever and stepped cam assembly into place. Wind the spring **COUNTERCLOCKWISE** a couple turns, and then hook the loop around the post on the body. The spring tension will be adjusted later when the oil control link rod is installed. Push the driven cam down the oil pump bore until the cam rests against the stepped cam.

4- Install the O-ring into the groove on the base of the pump. Place the bottom cover over the O-ring with the tang on the



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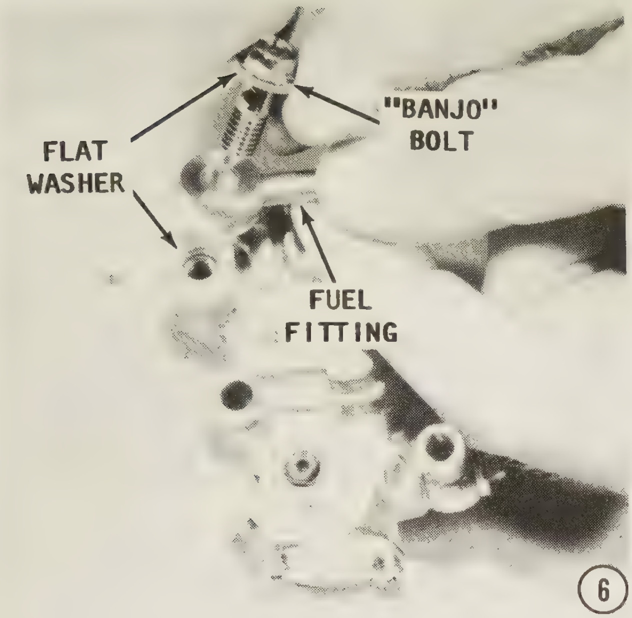

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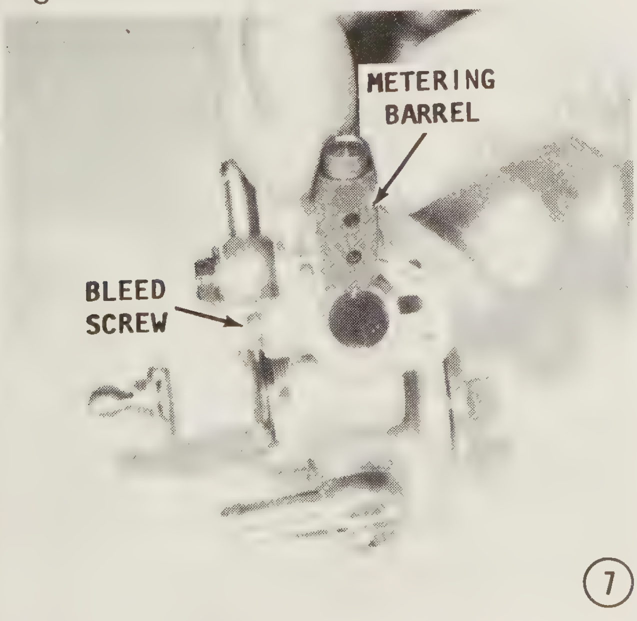
cover facing downward. Install and tighten the two Phillips head screws with their captive lockwashers.

5- Install a flat washer, the oil inlet fitting, another flat washer, and the "Banjo" bolt into the lower opening of the pump.

6- Install the flat washer, oil outlet fitting, another flat washer, and the "Banjo" bolt into the upper opening on the pump.

7- Slide the metering barrel into the pump bore with the posts on the driven cam indexing with the holes in the barrel. Install and tighten the bleed screw and the gasket/washer.

8- Install the O-ring into the groove on the top of the pump. Slide the spring down over the metering barrel and insert the oil regulator into the center of the barrel.



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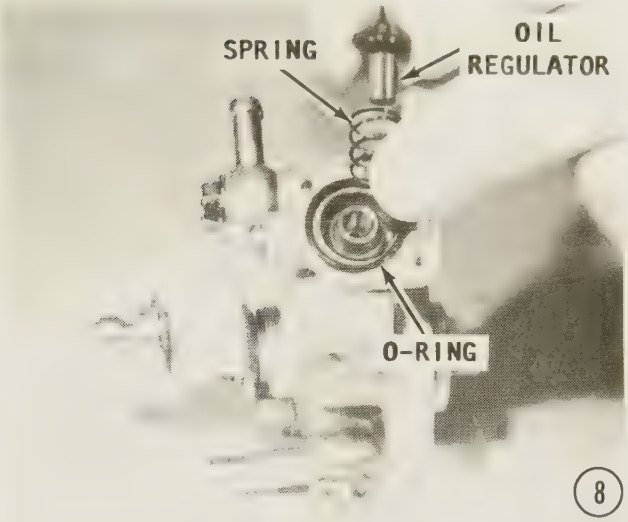

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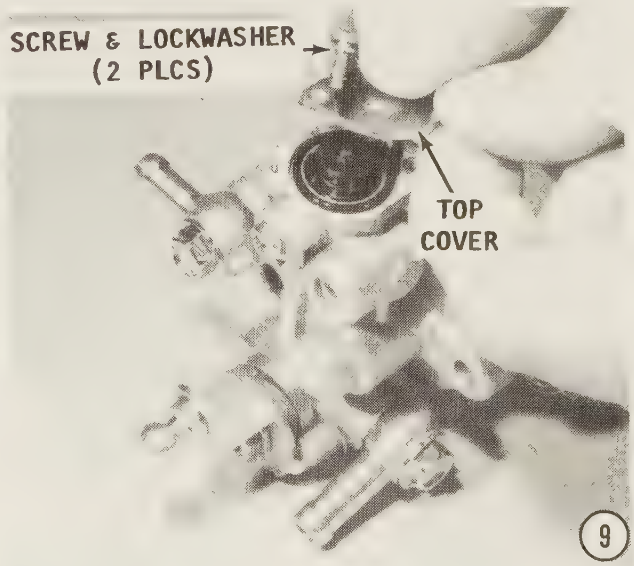
9- Place the top cover over the pump with the dimple in the cover facing upward. Install and tighten the two Phillips head screws with captive lockwashers. Tighten the screws securely.

The pump is now ready for installation to the powerhead.



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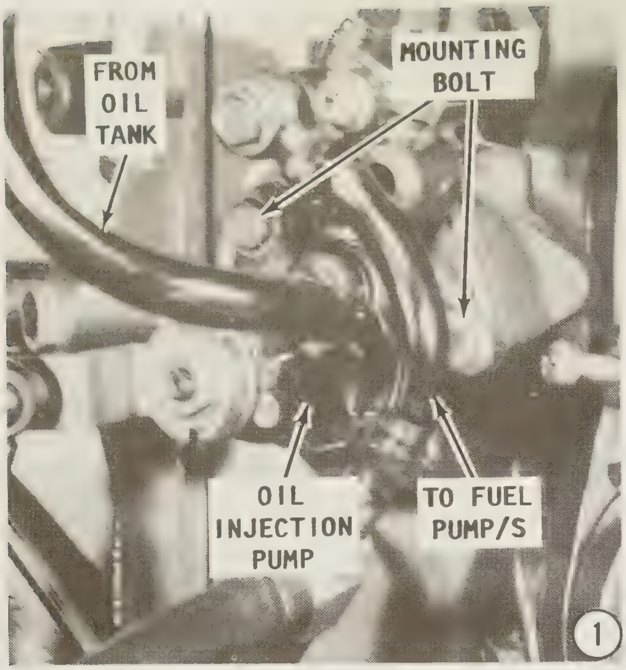
INSTALLATION

1- Check to be sure the shaft of the oil pump will index into the slot at the center of the crankshaft driven shaft. If the two are no longer aligned, rotate the pump shaft to match the slot in the driven shaft. Install the oil pump with the pump shaft indexed into the slot on the driven shaft. Secure the pump to the powerhead with the two attaching bolts. Tighten the bolts securely.

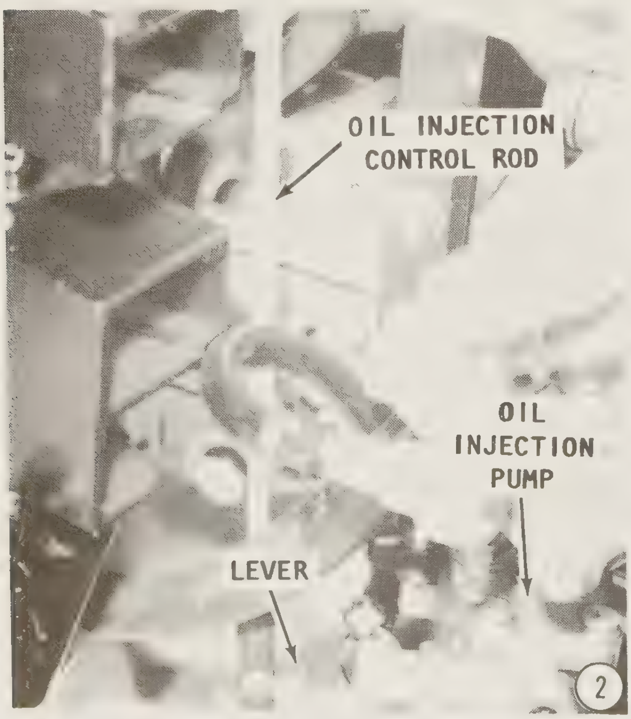
Connect the line from the tank to the lower pump fitting. Connect the line from the fuel pump to the upper pump fitting.



2- Snap the oil injection link rod back onto the ball joint on the pump lever. If the length of this link rod was accidentally altered -- see Page 4-86 to adjust the rod to the correct length. Consult the Table of Contents for the model being serviced.

Adjust the return spring tension on the lever shaft to permit the correct amount of friction for the lever to stay in place when the rod is moved.

3- Fill and bleed the oil injection system according to the procedures beginning on Page 4-85.



OIL PUMP FLOW TEST

The oil pump output may be tested for proper operation as follows.

a- Connect a remote fuel source to the powerhead with a 50:1 oil and fuel pre-mix. Install a flush device to the lower unit or place the outboard in a test tank.

b- Remove the cowling and disconnect the oil pump output line (clear hose) from the fuel line "Tee" fitting. Plug the fuel line to prevent any fuel leakage while the outboard is operating.

c- Disconnect the link rod from the oil pump lever. Set the oil pump lever as indicated in the flow specifications below.

d- Place the oil pump output hose into a graduated container, 0 to 250cc or equivalent. Start the powerhead and operate it at the rpm and for the length of time specific below.

Flow Specifications

135hp to 175hp

1500 rpm for 3 minutes, with the oil lever set for **MINIMUM** oil flow = 6.8cc ±10%.

1500 rpm for 3 minutes, with the oil lever set for **MAXIMUM** oil flow = 17.0cc ±10%.

200hp

1500 rpm for 3 minutes, with the oil lever set for **MINIMUM** oil flow = 8.2cc ±10%.

1500 rpm for 3 minutes, with the oil lever set for **MAXIMUM** oil flow = 19.2cc ±10%.

225hp

1500 rpm for 3 minutes, with the oil lever set for **MINIMUM** oil flow = 6.8cc ±10%.

1500 rpm for 3 minutes, with the oil lever set for **MAXIMUM** oil flow = 31.5cc ±10%.

275hp

700 rpm for 15 minutes, oil lever set for **MAXIMUM** oil flow = 61.25cc ±10%.

5
IGNITION

5-1 INTRODUCTION

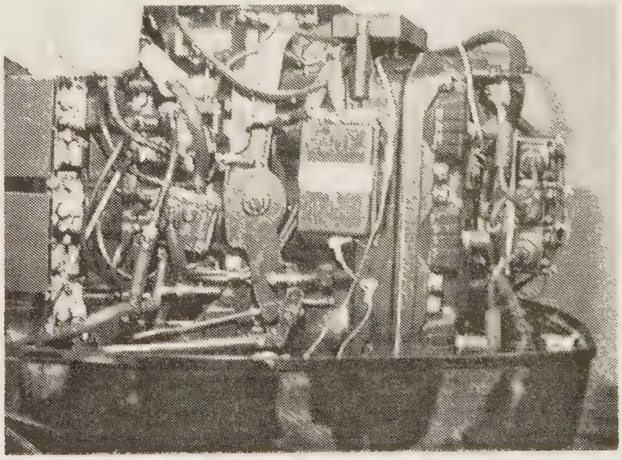
The less an outboard is operated, the more care it needs. Allowing an outboard to remain idle will do more harm than if it is used regularly. To maintain the powerhead in top shape and always ready for efficient operation at any time, the unit should be operated about once a month throughout the year. If stored, mounted on the boat, a flush attachment can be attached and the unit operated at idle.

The carburetion and ignition principles of two-cycle engine operation **MUST** be understood in order to perform a proper tune-up on an outboard powerhead.

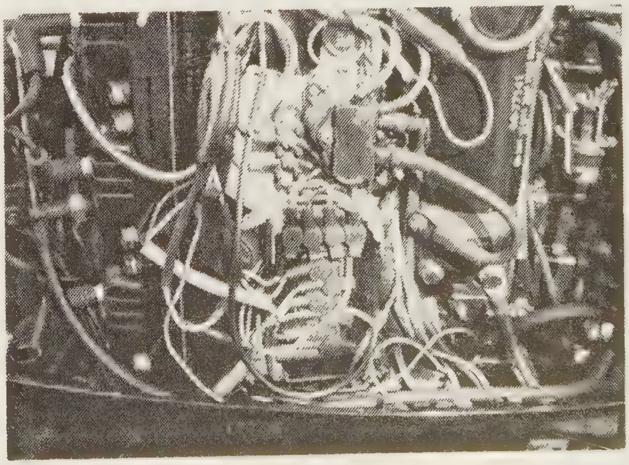
If any doubts exist concerning an understanding of two-cycle engine operation, it would be best to study the operation theory section in the first portion of Chapter 8, before tackling any work on the ignition system.

Only one ignition system is used on the powerheads covered in this manual. The system is classified as a "Thunderbolt CD" (capacitor discharge) system with an ignition coil for each cylinder. A description and theory of

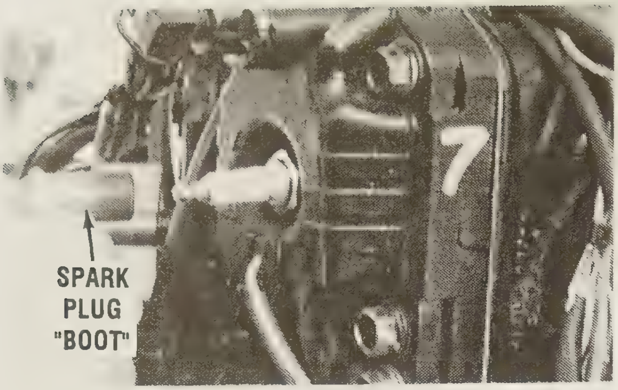
A Model 175 V6 outboard -- serviced and ready to give the owner "fun days" on the water.



Port side of a V6 powerhead with the cowling removed exposing most of the timing and throttle adjustments.



Starboard side of the same outboard as above, with a host of ignition and electrical items in clear view.



ALWAYS use a pulling and twisting motion on the high-tension "boot" when making a disconnect from the spark plug.

operation begins on Page 5-5, followed by complete, detailed troubleshooting procedures, and service instructions, including testing of various components. A section covering the "black box" modules is also presented in this chapter. The "black box" modules are so named because they are a sealed unit and cannot be serviced. If accurate troubleshooting leads to one of these modules as the cause of an ignition problem, the unit **MUST** be replaced.

Comprehensive synchronizing procedures are outlined in Chapter 6.

5-2 SPARK PLUG EVALUATION

Removal

Remove the spark plug wires by pulling and twisting on only the molded cap. **NEVER** pull on the wire or the connection inside the cap may become separated or the boot damaged. Remove the spark plugs and keep them in order. **TAKE CARE** not to tilt the socket as you remove the plug or the insulator may be cracked.

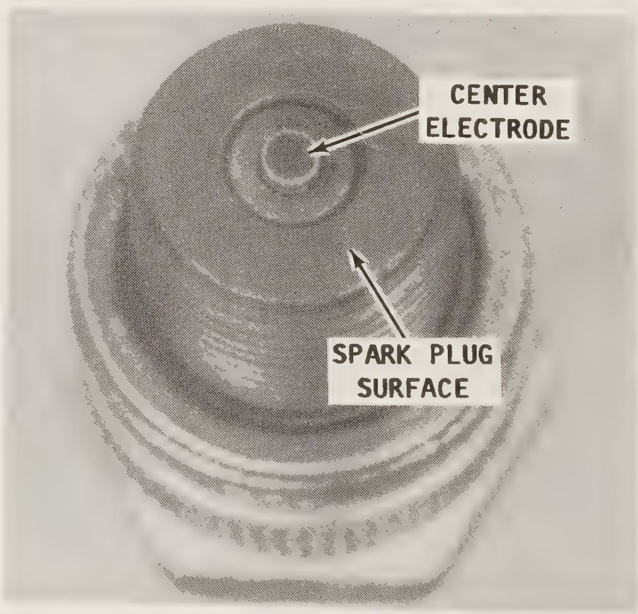
Examine

Line the plugs in order of removal and carefully examine them to determine the

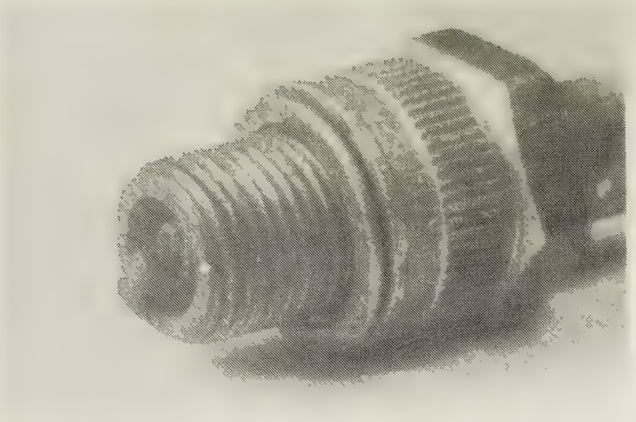
*Damaged spark plugs. Notice the broken electrode on the left plug. The missing part **MUST** be found and removed before returning the powerhead to service, to prevent serious damage to expensive internal parts.*

This spark plug is foul from operating with an overrich air/fuel mixture, possibly caused by an improper carburetor adjustment.

firing conditions in each cylinder. If the side electrode is bent down onto the center electrode, the piston is traveling too far upward in the cylinder and striking the spark plug. Such damage indicates the piston pin or the rod bearing is worn excessively. In most cases, a powerhead overhaul is required to correct the condition. To verify the cause of the problem, rotate the flywheel manually. As the piston moves to the full up position, push on the piston crown with a screwdriver inserted through the spark plug hole, and at the same time rock the flywheel back and forth. If any play in the piston is detected, the powerhead must be rebuilt.



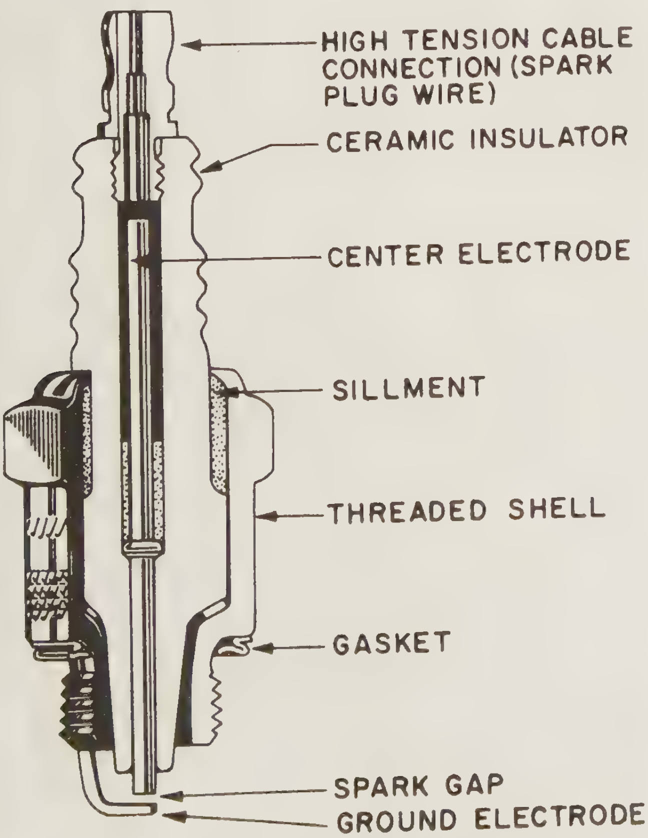
Example of a non-adjustable surface gap spark plug operated under favorable conditions.



This spark plug has been operating too-cold, because it is rated with a too-low heat range for the powerhead.

Correct Color

A proper firing plug should be dry and powdery. Hard deposits inside the shell indicate too much oil is being mixed with the fuel. The most important evidence is the light gray to tan color of the porcelain, which is an indication this plug has been running at the correct temperature. This means the plug is one with the correct heat range and also that the air-fuel mixture is correct.



Cutaway drawing of a typical spark plug with principle parts identified.

Rich Mixture

A black, sooty condition on both the spark plug shell and the porcelain is caused by an excessively rich air-fuel mixture, both at low and high speeds. The rich mixture lowers the combustion temperature so the spark plug does not run hot enough to burn off the deposits.

Deposits formed only on the shell is an indication the low-speed air-fuel mixture is too rich. At high speeds with the correct mixture, the temperature in the combustion chamber is high enough to burn off the deposits on the insulator.

Too Cool

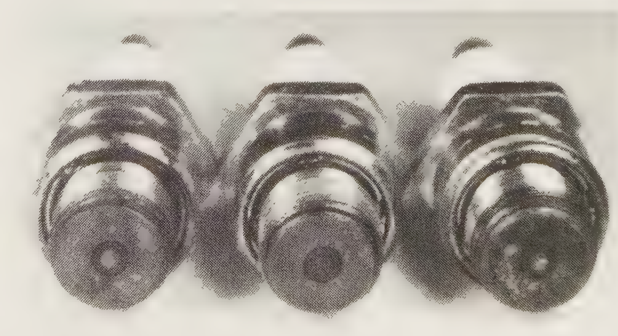
A dark insulator, with very few deposits, indicates the plug is running too cool. This condition can be caused by low compression or by using a spark plug of an incorrect heat range. If this condition shows on only one plug it is most usually caused by low compression in that cylinder. If all of the plugs have this appearance, then it is probably due to the plugs having a too-low heat range.

Fouled

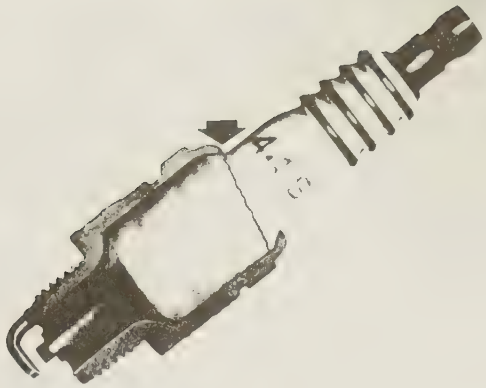
A fouled spark plug may be caused by the wet oily deposits on the insulator shorting the high-tension current to ground inside the shell. The condition may also be caused by ignition problems which prevent a high-tension pulse from being delivered to the spark plug.

Carbon Deposits

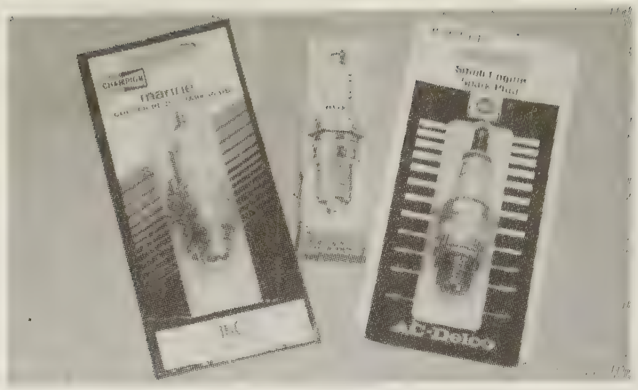
Heavy carbon-like deposits are an indication of excessive oil in the fuel. This condition may be the result of worn piston rings.



The spark plugs should be kept in order as they are removed from the powerhead to enable a proper diagnosis to be made of each cylinder operating condition .



A crack in the porcelain is usually caused by removing or installing the plug using the wrong size wrench. Such damage will cause the spark to be grounded by jumping from the crack to the base of the plug.



Today, numerous type spark plugs are available for service. ***ALWAYS*** *check with the Specifications or the local marine shop to be sure the manufacturer has not initiated a late-change for the model being serviced.*

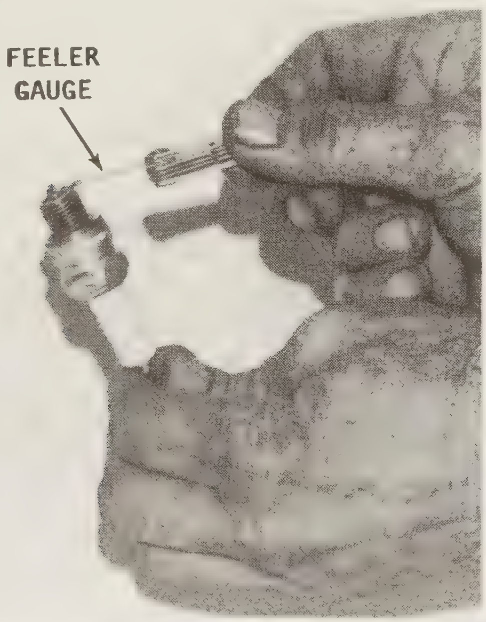
Overheating

A dead white or gray insulator, which is generally blistered, is an indication of overheating and pre-ignition. The electrode gap wear rate will be more than normal and in the case of pre-ignition, will actually cause the electrodes to melt as shown in this illustration. Overheating and pre-ignition are usually caused by overadvanced timing, detonation from using too-low an octane rating fuel, an excessively lean air-fuel mixture, or problems in the cooling system.

Electrode Wear

Electrode wear results in a wide gap and if the electrode becomes carbonized it will form a high-resistance path for the spark to jump across. Such a condition will cause the powerhead to misfire during acceleration. If all of the plugs are in this condition, it can cause an increase in fuel consumption and very poor performance at high-speed operation. The solution is to replace the spark plugs with a rating in the proper heat range and gapped to specification.

Red rust-colored deposits on the entire firing end of a spark plug can be caused by water in the cylinder combustion chamber. This can be the first evidence of water entering the cylinders through the exhaust manifold because of an accumulation of scale or defective exhaust shutter. This condition **MUST** be corrected at the first opportunity. Refer to Chapter 8, Powerhead Service.



The spark plug gap should always be checked with a wire-type feeler gauge before installing new or used plugs.

5-3 THUNDERBOLT CD IGNITION SYSTEM COIL PER CYLINDER

DESCRIPTION

The ignition system used on powerheads covered in this manual is totally electronic. The CD ignition system produces a higher voltage and spark at the plug along with a more accurate timing advancement than was possible with the conventional breaker point system installed on earlier models.

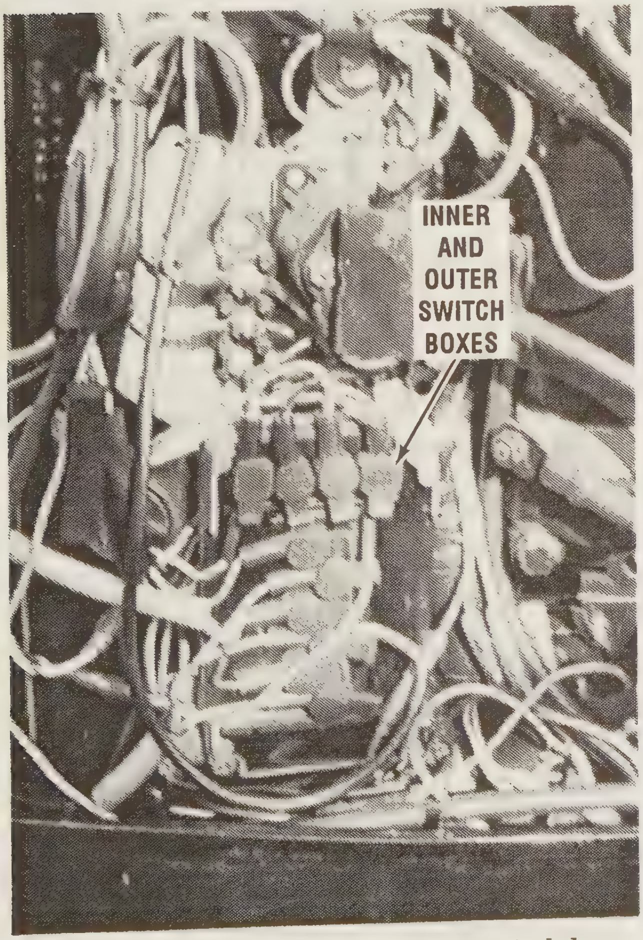
The system is an alternator-driven distributorless capacitor discharge system.

Components include a stator assembly, trigger assembly, two switchboxes, one igniton coil per cylinder, and one spark plug per cylinder.

The stator assembly is mounted below the flywheel and has six ignition coils. Permanent magnets are installed on the inside outer rim of the flywheel. The ignition coils produce AC voltage as the permanent magnets in the flywheel pass the stationary stator ignition coils. The AC voltage is conducted to the switchboxes where it is rectified and stored in a capacitor.

Theory of Operation

To begin a complete cycle: when the permanent magnets in the flywheel rim pass the stator ignition coils, AC voltage is produced. This voltage is conducted to the switch box where it is rectified and stored in the capacitor. When the second set of magnets pass the trigger coils, another AC voltage is produced and conducted to an electronic switch (SCR) in the switch box.



Location of the inner and outer switch boxes, mentioned in the text. The boxes are "stacked" one on top of the other. Therefore, the outer box must be removed to gain access to the inner one.

The switch discharges the capacitor voltage into the ignition coil at a precise time and in the proper firing order sequence.

The capacitor voltage is conducted to the primary windings of the ignition coil. When the field generated by the coil (actually an electrical pulse) collapses, a high AC voltage charge is generated in the secondary windings and then conducted through the high-tension leads to the spark plugs. This high-voltage jumps the gap between the electrodes of the spark plug and ignites the air/fuel mixture in the cylinder.

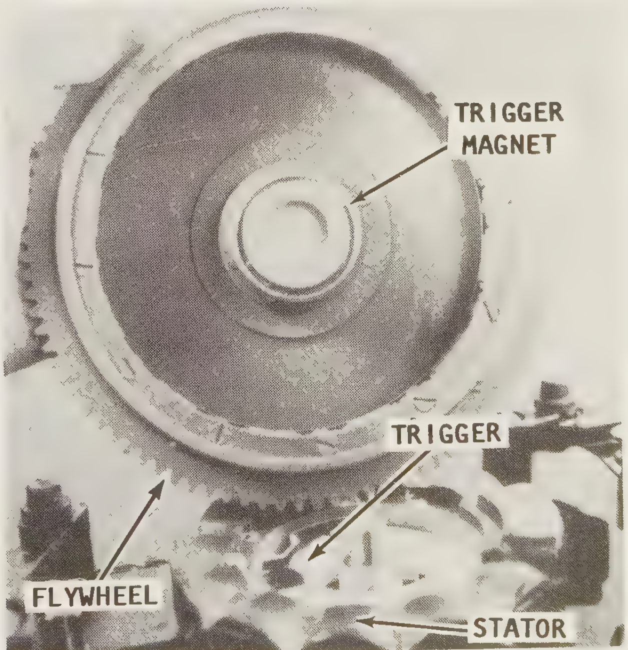
This sequence occurs once for each cylinder per crankshaft revolution.

Advance or retard is accomplished by rotating the trigger coil position in relation to the permanent magnets on the flywheel hub.

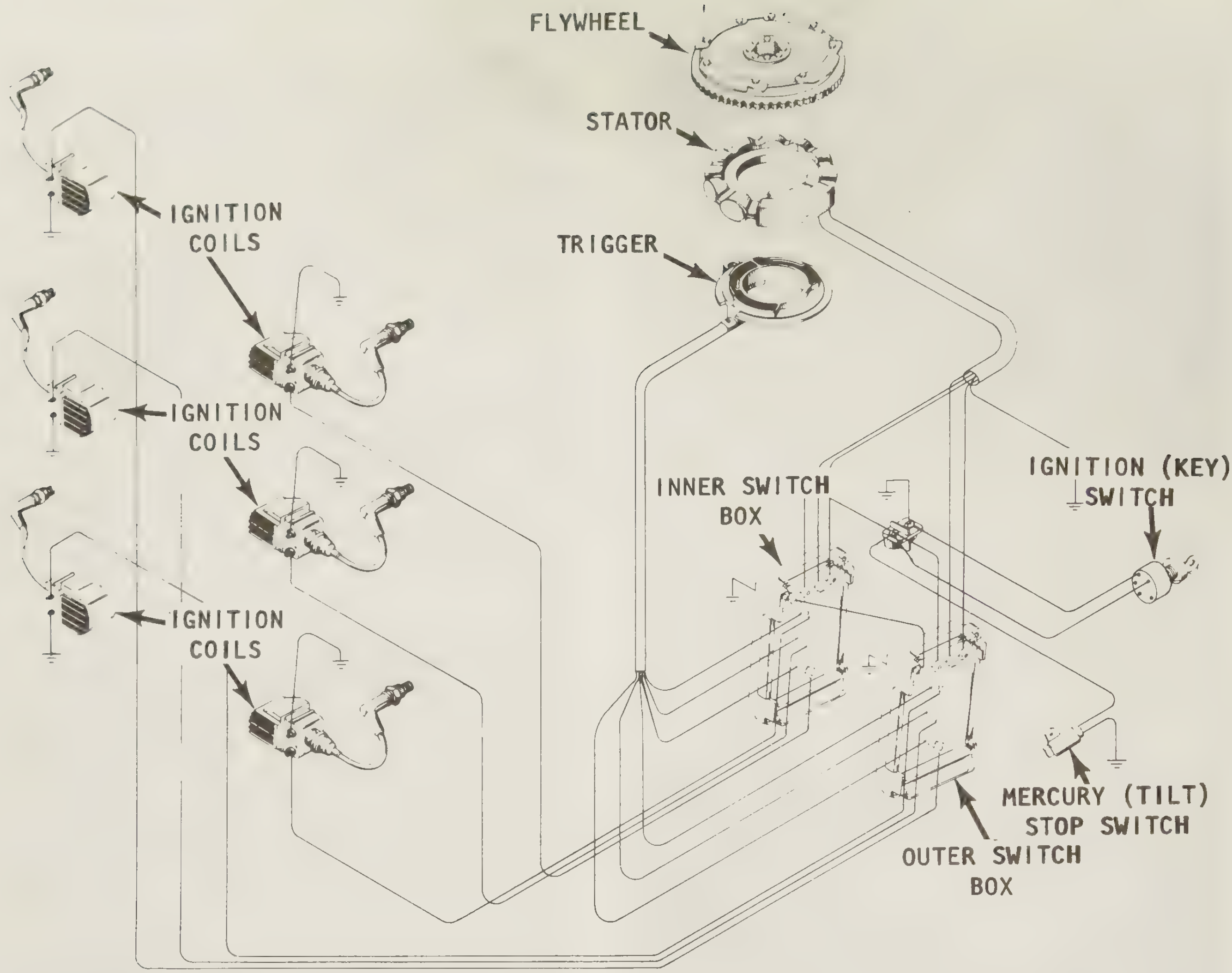
CRITICAL WORDS

These next two paragraphs may well be the most important words in this chapter. Misuse of the wiring harness is the greatest single cause of electrical problems with outboard power plants.

A wiring harness is used between the key switch and the powerhead. This harness seldom contains wire of sufficient size to allow connecting accessories. Therefore, anytime a new accessory is installed, **NEW** wiring should be used between the battery and the accessory. A separate fuse panel **MUST** be installed on the dash. To connect the fuse panel, use two red and black No. 10



Flywheel removed exposing the stator, trigger assembly and other ignition parts for testing and service.



Functional diagram of the Thunderbolt CD (Capacitor Discharge) ignition system used on many of the V6 powerheads covered in this manual.

gauge wires from the battery. CD ignition systems require a full 12 volts for proper operation. Therefore, again let it be said, **NEVER** connect accessories through the key switch.

Key Switch

A marine type key switch **MUST** be installed as a replacement item. An automotive type switch installation may cause damage to the system.

TROUBLESHOOTING THUNDERBOLT CD IGNITION SYSTEM

READ, BELIEVE, & OBEY

NEVER touch or disconnect any ignition part on a powerhead equipped with a CD ignition system while the powerhead is operating; while the key switch is in the **ON** position; or while the battery cables are connected, because very high voltage is present.

The following safety precautions are listed for your personal safety and to prevent damage to expensive parts.

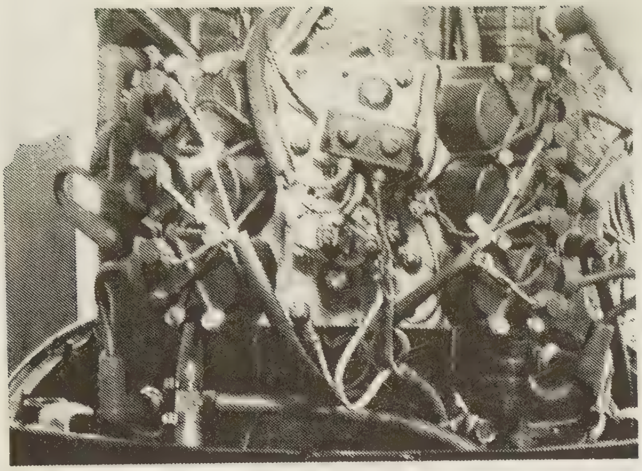
NEVER reverse battery cable connections. The battery negative (-) is ground. The black cable must always be connected to this terminal. The red cable must always be connected to the positive (+) terminal.

NEVER check polarity by "sparking" the battery terminals with the battery cable connections.

NEVER disconnect the battery cables while the powerhead is running.

NEVER crank the engine if the switch boxes are not properly grounded to the powerhead.

The switchboxes and ignition coils cannot be thoroughly checked with conventional



When troubleshooting the ignition system, do not overlook standard wiring -- cracked, broken leads or loose connections may be the cause of a problem.

test equipment. A Quicksilver Thunderbolt Ignition Analyzer is required to properly check these items.

All other components can be tested with a VOA (Volt/Ohm/Ampere) meter.

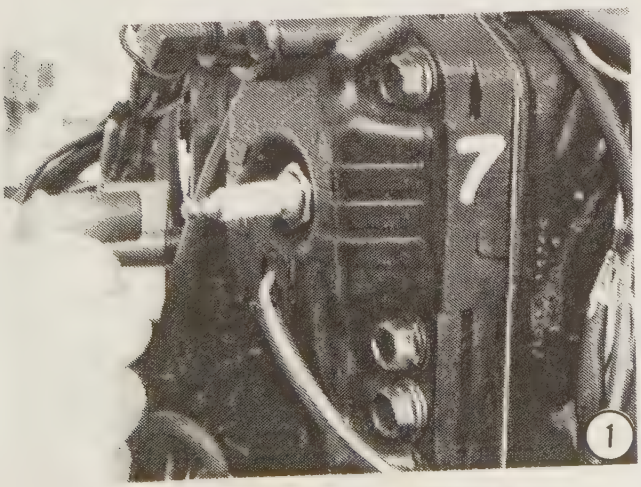
ALWAYS check the following areas for sources of trouble **BEFORE** opening up the ignition system.

Check to be sure the electrical harness, ignition switch, and mercury switch, are not the source of the problem.

Verify that the plug-in connectors are fully engaged and the terminals are free of corrosion.

Check to be sure all electrical components and/or ground wires are properly grounded to the powerhead. Inspect visible wire connections to be sure they are tight and free of corrosion.

Observe the entire electrical system for disconnected wires, and for short or open circuits.



Ready For Troubleshooting

Always attempt to proceed with the troubleshooting in an orderly manner. The "shot in the dark" approach will only result in wasted time, incorrect diagnosis, replacement of unnecessary parts, and frustration.

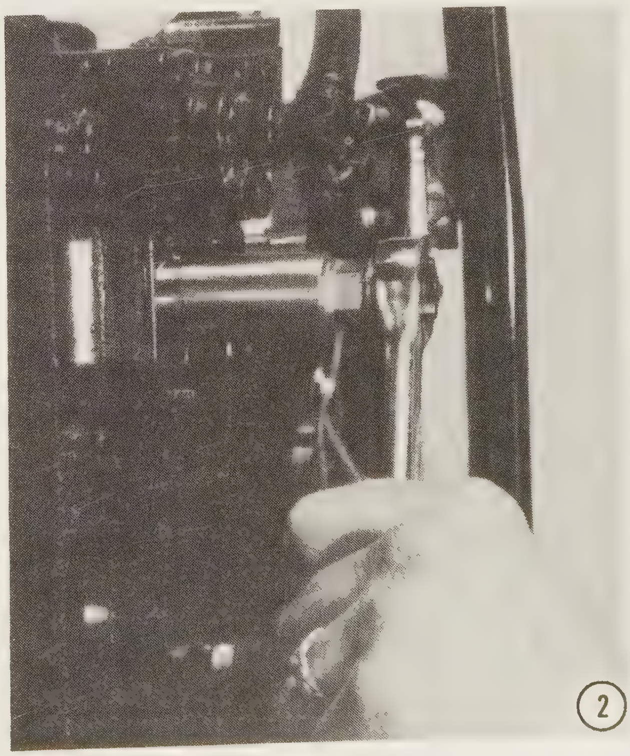
Begin the ignition system troubleshooting with the spark plugs and continue through the system until the source of trouble is located.

Spark Plugs

1- Check the plug wires to be sure they are properly connected. Check the entire length of the wires from the plugs to the coil. If the wire is to be removed from the spark plug, **ALWAYS** use a pulling and twisting motion as a precaution against damaging the connection.

2- Attempt to remove the spark plugs by hand. This is a rough test to determine if the plug is tightened properly. You should not be able to remove the plug without using the proper socket size tool. Remove the spark plugs and keep them in order. Examine each plug and evaluate its condition as described in Section 5-2.

3- Use a spark tester and check for spark at each cylinder. If a spark tester is not available, hold the plug wire about 1/4-inch from the powerhead. Rotate the fly-



wheel with a rope wrapped around the flywheel or with a cranking motor and check for spark. A strong spark over a wide gap must be observed when testing in this manner, because under compression a strong spark is necessary in order to ignite the air/fuel mixture in the cylinder. This means it is possible to think you have a strong spark, when in reality the spark will be too weak when the plug is installed. If there is no spark, or if the spark is weak, the trouble is most likely in the CD system.

ONE MORE WORD

Each cylinder in a Thunderbolt CD ignition system has its own ignition circuit. This means, if a weak spark is observed on any one cylinder and not at another, only the weak circuit is at fault. **HOWEVER**, it is considered "good shop practice" to check and service all circuits.

An intermittent, weak or **NO** spark at two spark plugs - one on each bank of three cylinders - is an indication the trigger pole on the trigger assembly is defective.

Loss of spark to all three cylinders on the same bank of cylinders is an indication the switch box for that bank of cylinders is defective.

Compression

4- Before spending too much time and money attempting to trace a problem to the ignition system, a compression check of each cylinder should be made. If the cylinder does not have adequate compression, troubleshooting and attempted service of the ignition or fuel system will fail to give satisfactory powerhead performance.

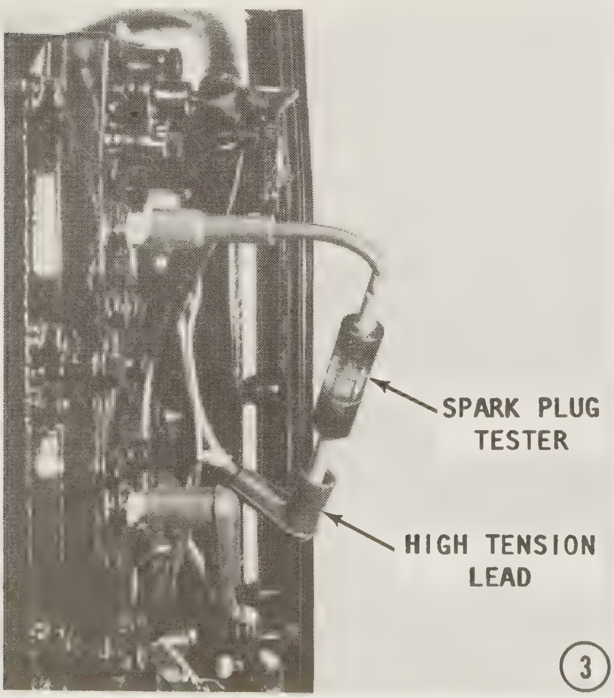
Remove the spark plug high tension leads by pulling and twisting **ONLY** on the molded cap. **NEVER** pull on the wire lead because the connection inside the cap may be separated or the boot may be damaged.

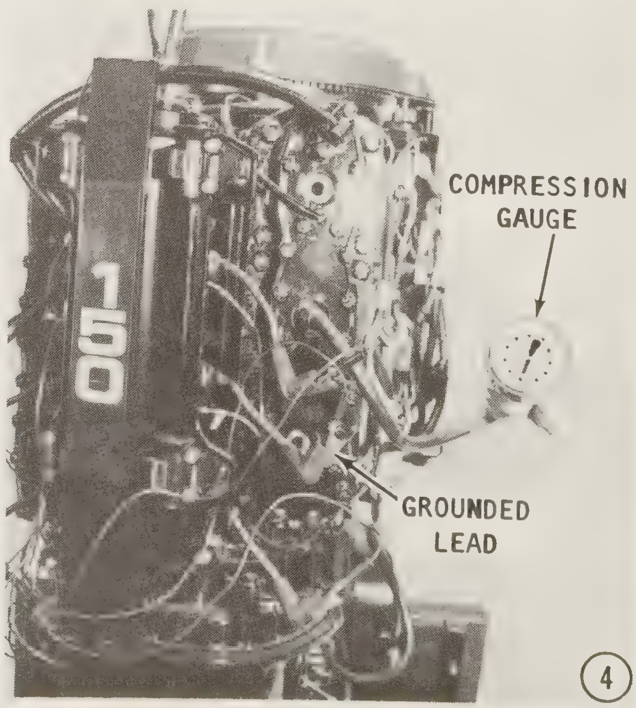
Remove the spark plugs. Insert a compression gauge into the cylinder spark plug opening. Crank the powerhead through several flywheel revolutions and note the highest compression reading. Repeat the procedure for each cylinder. The manufacturer refuses to give a specific acceptable compression reading for any of their powerheads from the single cylinder units to the V6 and V8 units. A general figure might be in the neighborhood of 125 psi for a V6 powerhead.

A variation in reading between the cylinders is far more important than the actual individual readings. If a particular cylinder varies more than 15 psi from the others, the cylinder may be scored, the rings frozen, or the piston burned. Mercury/Mariner V-6 powerheads use cylinder heads on each bank of cylinders. Therefore, low compression in one cylinder could be attributed to a blown head gasket or sealing ring.

Stator Types

Two different type stator assemblies are installed on powerheads with the Thunderbolt





THUNDERBOLT C.D. IGNITION CHECKS

STATOR CHECKS

MODEL	YEAR	MULTIMETER LEADS	CONNECTED TO:	METER SCALE SETTING	ALLOWABLE METER LIMITS
All 135 Thru 200 and 275	1990 and On	RED BLACK	Blue Stator Lead Red Stator Lead	R x 1000	3500 - 4200 OHMS
		RED BLACK	Blue/White Stator Lead Red/White Stator Lead	R x 1000	3500 - 4200 OHMS
		RED BLACK	Red Stator Lead Black Stator Lead or Ground	R x 1	90 - 140 OHMS
		RED BLACK	Red/White Stator Lead Black Stator Lead or Ground	R x 1	90 - 140 OHMS
		RED BLACK	Yellow or Yellow/Red Stator Leads Yellow or Yellow/Red Stator Leads	R x 1	0.25 - 0.45 OHMS
		RED BLACK	Yellow or Yellow/Red Ground	R x 1000	No Continuity

TRIGGER CHECKS

MODEL	YEAR	MULTIMETER LEADS	CONNECTED TO:	METER SCALE SETTING	ALLOWABLE METER LIMITS
All 135 Thru 200 and 275	1990 and On	RED BLACK	Brown Trigger Lead White Trigger Lead	R x 100	1100 - 1400 OHMS
		RED BLACK	White Trigger Lead Purple Trigger Lead	R x 100	1100 - 1400 OHMS
		RED BLACK	Purple Trigger Lead Brown Trigger Lead	R x 100	1100 - 1400 OHMS

IGNITION COIL CHECKS

MODEL	YEAR	MULTIMETER LEADS	CONNECTED TO:	METER SCALE SETTING	ALLOWABLE METER LIMITS
All 135 Thru 200 and 275	1990 and On	RED BLACK	Positive Terminal Negative Terminal	R x 1	0.02 - 0.04 OHMS
		RED BLACK	Coil Tower Negative Terminal	R x 1000	No Reading

CD ignition system. One type has a Black ground wire. The stator is grounded to the powerhead through this Black ground wire.

The other type stator does not have the Black ground wire. The stator is grounded directly to the powerhead through the stator mounting plate.

Switch Box Testing

Two switch boxes are installed on V6 powerheads. Each switch box services three cylinders. The boxes are stacked on the powerhead -- one on top of the other. The top (outer), box must be removed in order to service the bottom (inner), box.

NOW, THESE WORDS

Refer to the wiring diagram on the next page for correct color coded wire location.

CAUTION

The switch boxes **MUST** be properly grounded to the powerhead before cranking or the switch boxes will be damaged.

The stator **MUST** be grounded to the powerhead. Disconnect the Blue/White and Red/White stator leads from the outer switch box. Disconnect the Blue and Red stator leads from the inner switch box.

If the specified readings are not obtained, the stator assembly **MUST** be replaced. Service procedures are given later in this chapter.

Trigger Assembly Test

FIRST, these words: The switch boxes **MUST** be disconnected from the trigger coil assembly before making this test.

Connect the VOA test meter leads to the color coded wires as indicated in the test table.

If the test meter does **NOT** indicate the value as indicated in the table, the trigger coil is defective and **MUST** be replaced, as outlined later in this chapter.

Ignition Coil Test

FIRST, these words: A VOA meter is only capable of detecting certain faults in an ignition coil. Replace the coil, if the meter readings are not as specified in the accompanying chart. If the coil tests are satisfactory, but the coil is still suspected, an Ignition Analyzer must be used to check the coil further. If an analyzer is not available, the coil should be replaced or checked at the local Mercury/Mariner dealer.

CAUTION

The switch boxes **MUST** be properly grounded to the powerhead before cranking the engine, or the switch boxes will be damaged.

Continuity Test
Shift Box Side
Remote Control Harness Connector

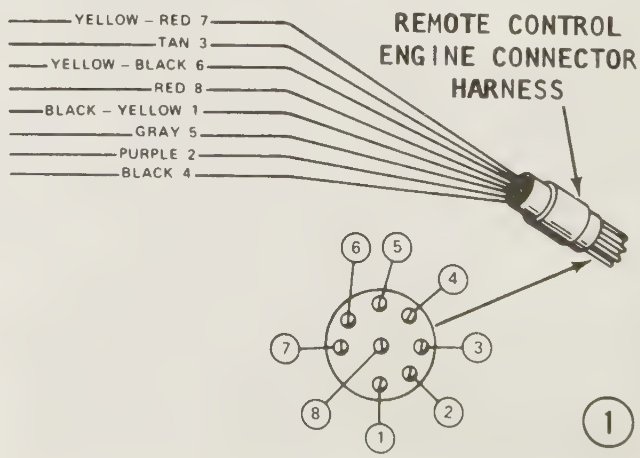
1- Remove the remote control wiring harness and the instrument panel connectors at the powerhead. The wiring diagrams in the Appendix will be helpful when making the connections after testing. Connect one lead of the ohmmeter to the No. 7 terminal and the other lead to the No. 4 terminal of the remote control harness connector. Use the RX1 scale. Check to be sure the key switch is in the **OFF** position. The ohmmeter **MUST** indicate continuity.

Connect one meter lead to terminal No. 1 of the remote control harness connector and the other test lead to terminal "A" of the instrument panel connector. Move the key switch to the **RUN** position. The ohmmeter **MUST** indicate continuity.

Check to be sure the shift lever is in the neutral position. Connect one lead of the ohmmeter to terminal No. 1 and the other lead to terminal No. 3 of the remote control harness connector. Move the key switch to the **RUN/START** position. The ohmmeter **MUST** indicate continuity.

Ignition Switch Test
Commander Shift Box Installation

2- Remove the remote control wiring harness and the instrument panel connectors at the powerhead. The wiring diagrams in the Appendix will be helpful when making connections after testing. Connect one



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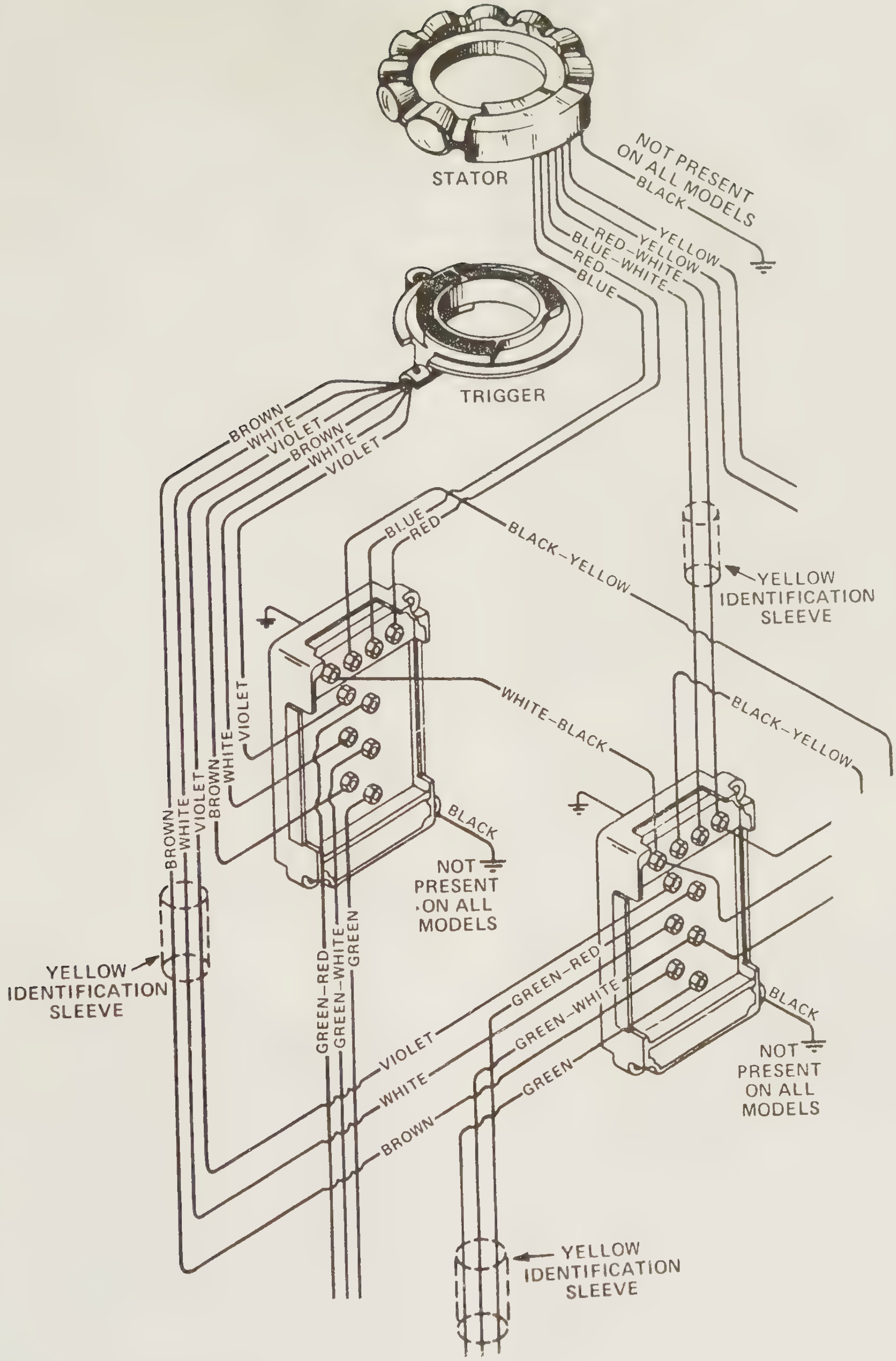
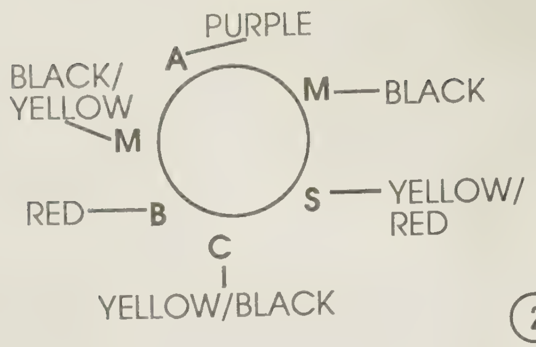


Functional wiring diagram of the Thunderbolt CD ignition system covered in this chapter. The switch boxes are stacked one on top of the other. Therefore, the top (outer) box must be removed to gain access to the bottom (inner) box.



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ohmmeter lead to the Black (M) terminal and the other lead to the Black/Yellow (M) terminal of the remote control harness connector. Use the RX1 scale. Check to be sure the key switch is in the **OFF** position. The ohmmeter **MUST** indicate continuity.

Connect one ohmmeter lead to the Red (B) terminal and the other lead to the Purple (A) terminal of the remote control harness connector. Use the RX1 scale. Rotate the key switch to the **RUN** position. The ohmmeter **MUST** indicate continuity.

Check to be sure the shift lever is in the **NEUTRAL** position. Connect one ohmmeter lead to the Red (B) terminal and the other lead to the Yellow/Red (S) terminal of the remote control harness connector. Move the key switch to the **RUN/START** position. The ohmmeter **MUST** indicate continuity.

Keep the key switch in the **RUN/START** position and check for continuity between the Purple (A) terminal and the Yellow/Red (S) terminal. Repeat the continuity check between the Red (B) terminal and the Purple (A) terminal on the remote harness connector. In each test, the ohmmeter **MUST** indicate continuity.

Position the key switch in the **CHOKE** position. Connect one ohmmeter lead to the Red (B) terminal and the other lead to the Yellow/Black (C) terminal of the remote control harness connector.

Keep the key switch in the **CHOKE** position and check for continuity between the Purple (A) terminal and the Red (B) terminal. Repeat the continuity check between the Yellow/Black (C) terminal and the Purple (A) terminal on the remote harness connector. In each test the ohmmeter **MUST** indicate continuity.

If the meter readings are other than as specified during any of the above tests, recheck the ignition switch soldered connections to verify the switch and not the wiring is at fault. Replace the switch **ONLY** with a

1

Mercury/Mariner switch because an automobile type switch will damage the CD unit.

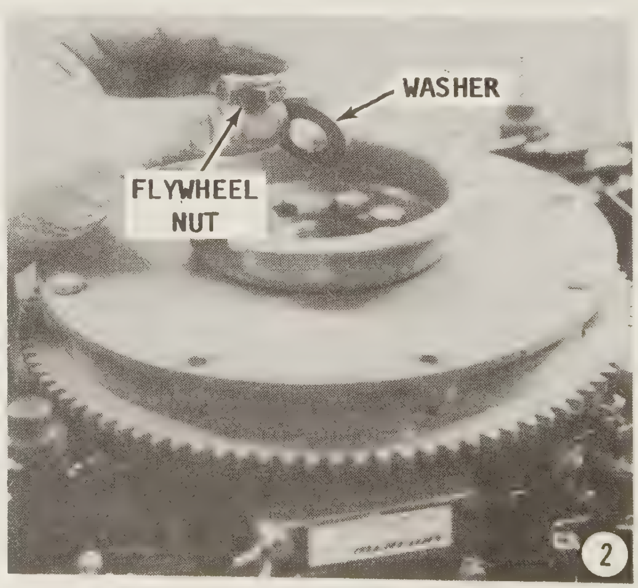
SERVICING THUNDERBOLT CD IGNITION SYSTEM

Any CD ignition system installed on a powerhead covered in this manual will usually operate over extremely long periods of time without requiring adjustment or repair. However, if ignition system problems are encountered, and the usual corrective actions such as replacement of spark plugs and timing does not correct the problem, the CD output should be checked to determine if the unit is functioning properly.

Overhaul procedures may differ slightly on various outboard models, but the following general basic instruction will apply to all Mercury/Mariner high-speed flywheel CD ignition systems.

Flywheel Removal

1- Remove the three wing-nuts and then enough of the cover to expose the flywheel.



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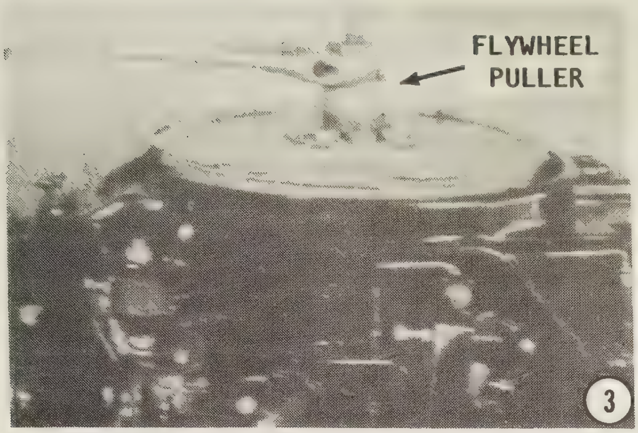
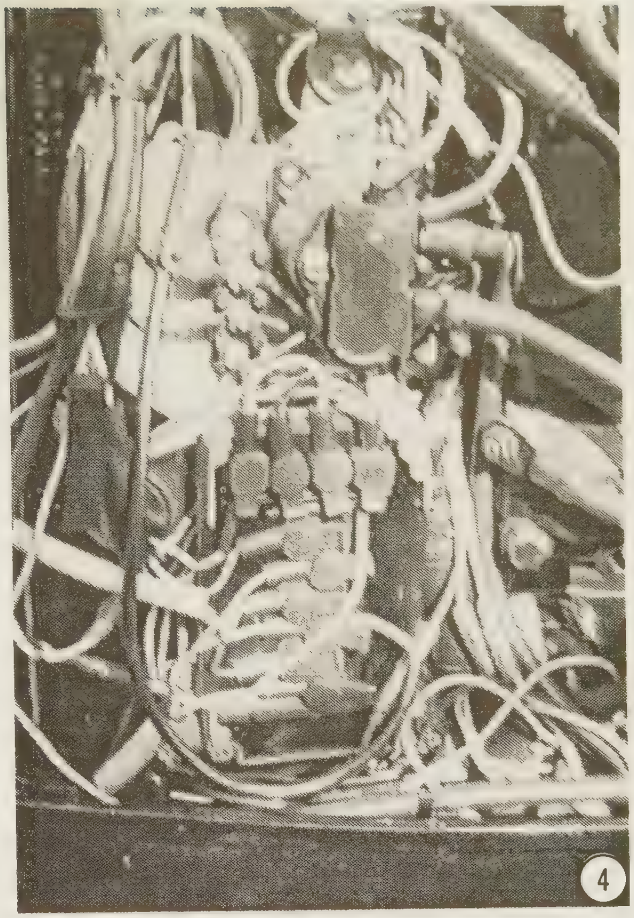


Disconnect the leads from the battery terminals.

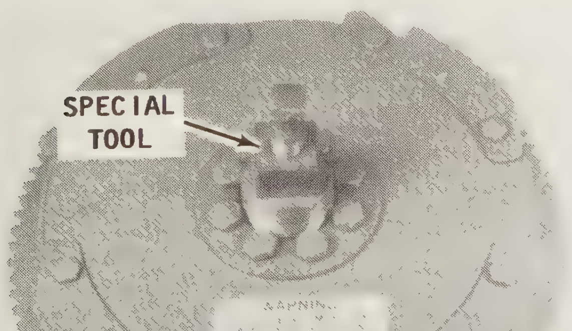
2- Remove the crankshaft nut in the center of the flywheel. A flywheel strap may be required to hold the flywheel securely while the nut is loosened.

3- Obtain the proper type flywheel puller. **NEVER** attempt to use a puller which pulls on the outside edge of the flywheel or the flywheel may be damaged. After the puller is installed, tighten the center screw onto the end of the crankshaft. Continue tightening the screw until the flywheel is released from the crankshaft. Remove the flywheel. **NEVER** hammer on or heat the end of the puller center bolt in an effort to remove the flywheel. Such action will damage the crankshaft or the bearings.

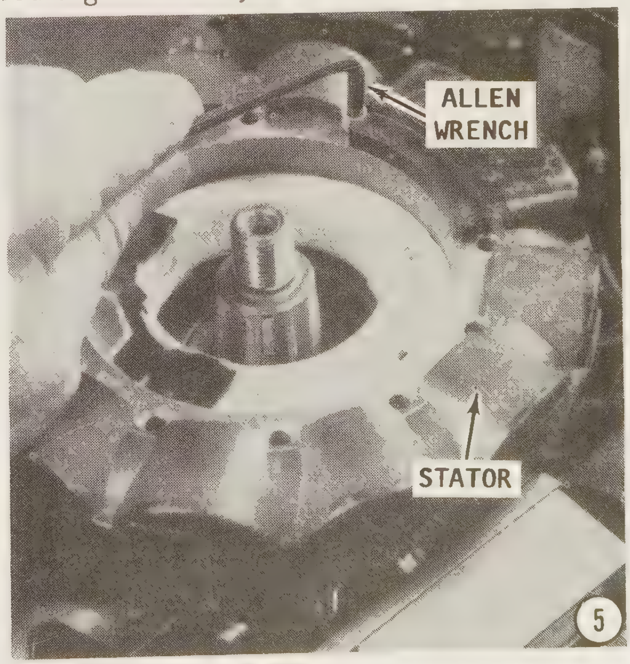
4- STOP, and carefully observe the layout of the electrical system and associated wiring. Study how the CD system is assembled. Because there are so many different CD installation arrangements, it is not possible to illustrate all of them, and even if they were shown, you would not be able to identify the circuitry for the engine being serviced.



TAKE TIME to make notes of the wire routing. You may elect to follow the prac-



The small investment involved to purchase the proper tool for removal of the flywheel will save much frustration, time, and possibly replacement of expensive parts.



tice of many professional mechanics by taking a series of photographs of the powerhead with the flywheel removed -- one from the top, and a couple from the sides showing the wiring and arrangement of parts.

5- Remove the four stator attaching screws using an Allen Wrench. Lift the stator and set it aside. It is not necessary to disconnect the wiring to the stator. See the chart on Page 5-9 to test the stator.

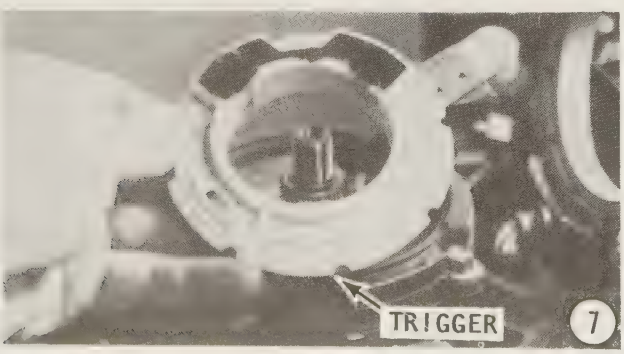
6- Remove the locknut securing the link rod swivel into the spark advance lever. Pull the link rod out of the lever.

7- Disconnect all trigger assembly leads from the switch box. Lift the trigger assembly from the powerhead. See the table on Page 5-9 to test the trigger assembly.

CLEANING AND INSPECTING

Inspect the flywheel for cracks or other damage, especially around the inside of the center hub. A damaged flywheel can be **EXTREMELY** dangerous. The forces exerted on the flywheel while it is spinning at high rpm are sufficient to shatter an unbalanced damaged flywheel. Inspect the magnets to see if they are held tightly around the outer circumference of the flywheel rim. Check the surface of the magnets for fractures and grooves.

Grooves around the inner perimeter would indicate a component mounted on the



stator plate is not aligned properly or the component is loose. Fractured or damaged magnets cannot be replaced. Both the magnets and flywheel share the same part number, therefore attempting to remove the magnets would be a pointless task. If magnets or the flywheel is defective, the entire flywheel must be replaced.

Check to be sure small metal particles have not become attached to the magnets. Verify each magnet has good magnetism by using a screwdriver or other suitable tool.

Thoroughly clean the inside taper of the flywheel and the taper on the crankshaft to prevent the flywheel from "walking" on the crankshaft during operation.

Check the top seal around the crankshaft to be sure oil has not been leaking onto the stator plate. If there is **ANY** evidence the seal has been leaking, it **MUST** be replaced.

Test the stator assembly to verify it is not loose. Attempt to lift each side of the plate. There should be little or no evidence of movement.

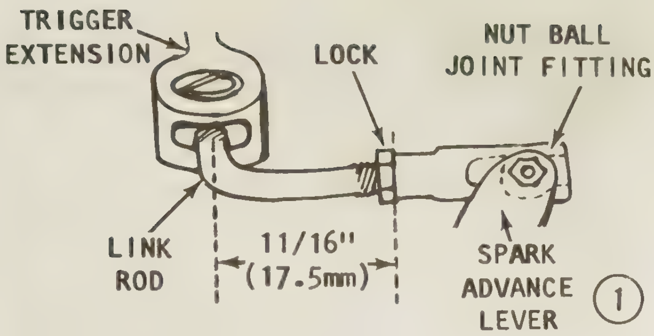
SPECIAL WORDS ON FLYWHEEL MAGNETS

The outer ends of any magnet are called poles. One end is the north pole and the other end is the south pole. The magnetic field surrounding a magnet is concentrated around these two poles.

Some flywheel magnets are fairly long and curved around the outer perimeter of the underside of the flywheel. Others are short and are mounted around the center hub, depending on the location of the coils mounted on the stator. Magnets are usually installed in pairs with the north pole of one adjacent to the south pole of its neighbor and so on. In this manner continuous magnetic field surrounds the inside of the flywheel.

If a flywheel is accidently dropped, not only could the teeth be damaged, but the impact will weaken the magnetic strength of all the magnets housed in the flywheel.

If one or more of the magnets should break or fracture, two new magnetic poles will be created. A long magnet with two poles will become two short magnets with four poles. The new poles will possess only half the magnetic strength of an original pole. The overall magnetic field will be



altered. The new field of the shorter magnets will not extend to cover the area of the flywheel.

Serious consequences apply to a CD type ignition system in the event of a flywheel magnet fracture. Trigger coils evenly spaced around the perimeter of the stator plate are energized by the concentrated magnetic field at the magnet poles. If new poles are suddenly created, the trigger will receive conflicting signals from the magnets and may even attempt to fire the cylinder twice in one revolution.

All these reasons require the flywheel to be handled with CARE.

ASSEMBLING FLYWHEEL PARTS

1- Place the trigger onto the powerhead in the upper end cap. Fasten the link rod swivel to the spark advance lever and secure it in place with the locknut.

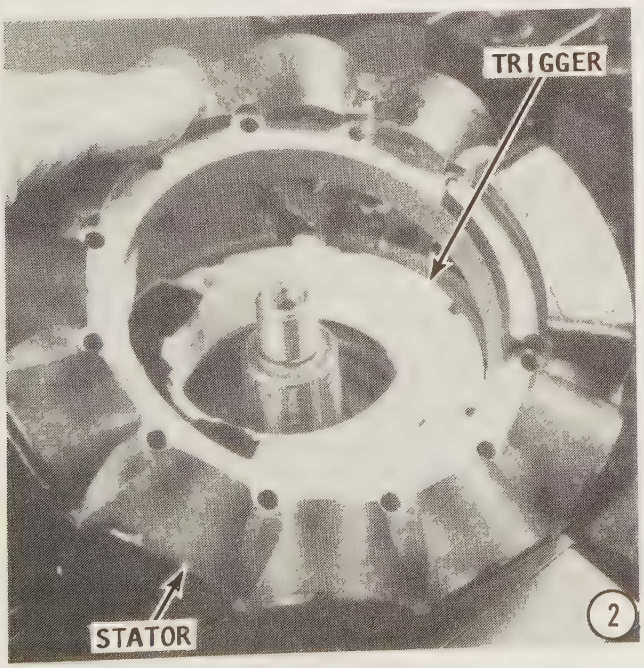
Adjust the locknut to obtain a distance of 11/16" (17.5mm) between the axis of the trigger extension and the outer edge of the locknut. No adjustment is required for in-line powerheads.

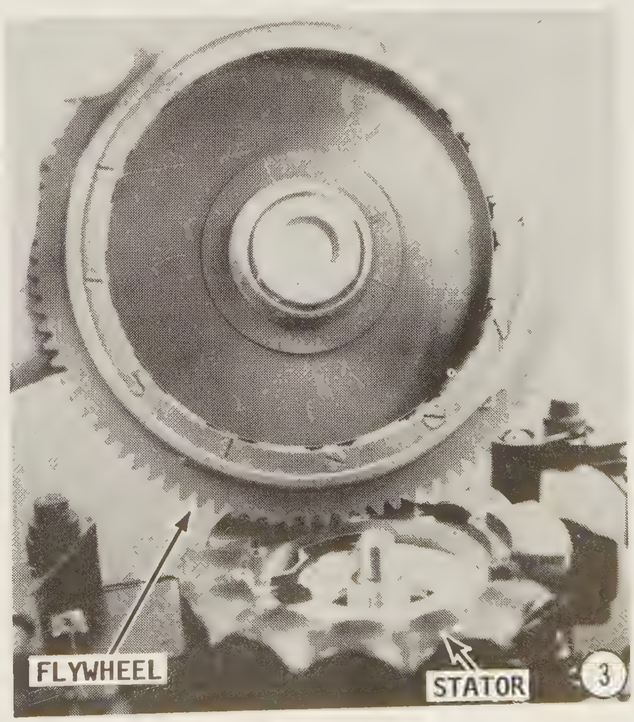
Route the trigger wiring harness along the side of the powerhead and then connect the wires to the proper terminals in the switch box. Refer to the diagram or photographs made before removal. If this was not done, check the wiring diagrams in the Appendix. Wires with yellow sleeves **MUST** be connected to the terminals of the switch box.

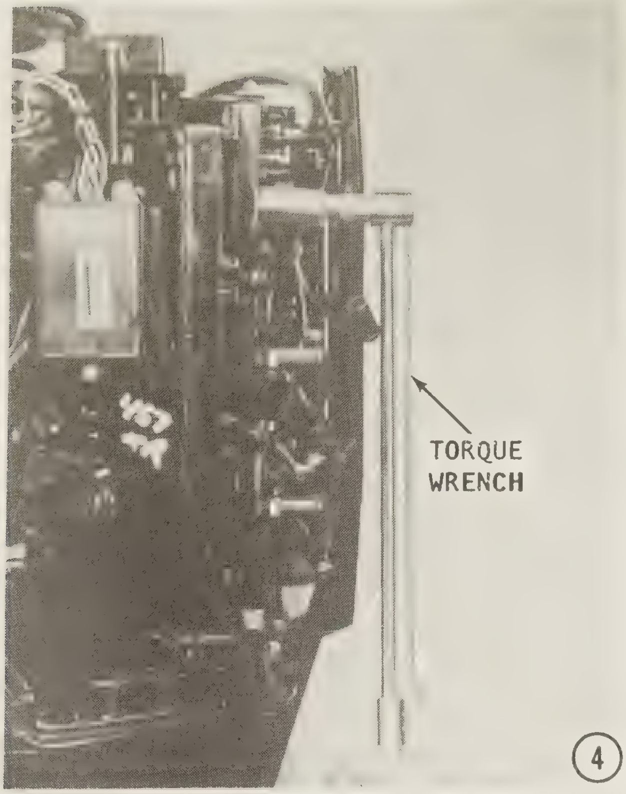
2- Place the stator in position over the trigger assembly. Apply a drop of Loctite A, or equivalent, to the threads of the stator attaching screws. Install and tighten the attaching screws to a torque value of 30 in lb (3.4Nm). Connect the stator leads to the proper terminals of the rectifier and switch box. Refer to the wiring diagrams in the Appendix. Wires with the yellow sleeves **MUST** be connected to the terminals of the outer switch box.

Flywheel Installation

3- Place the key in the crankshaft keyway. Check the flywheel magnets to be sure they are free of any metal parts. Double check the taper in the flywheel hub and the taper on the crankshaft to verify they are clean and contain no oil, as a precaution against the flywheel "walking" on the crankshaft during operation. Slide the flywheel







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down over the crankshaft with the keyway in the flywheel aligned with the key on the crankshaft. Rotate the flywheel clockwise and check to be sure the flywheel does not contact any part of the magneto or the wiring. Thread the flywheel nut onto the crankshaft and tighten it to the torque value given in the Appendix.

4- Install the spark plugs and tighten them to a torque value of 20.5 ft lb (27Nm). Install the electrical leads to the battery terminals.

For detailed timing and synchronizing procedures, see Chapter 6.

5-4 ELECTRONIC IDLE STABILIZER AND SPARK ADVANCE MODULES

All V6 powerheads covered in this manual are equipped with one or more of the following units or combination of units:

an idle stabilizer
and/or
a high speed advance module
and/or
a low speed/high speed spark advance module.

All of these units are "black boxes". By "black box" the term means the item is a sealed unit and cannot be opened or serviced. Therefore, if troubleshooting should indicate the module is defective, it **MUST** be replaced. In short, it either functions properly or it is replaced.

These "black box" units are usually installed on the upper front cowling support bracket, but may be found in other locations on various powerheads.

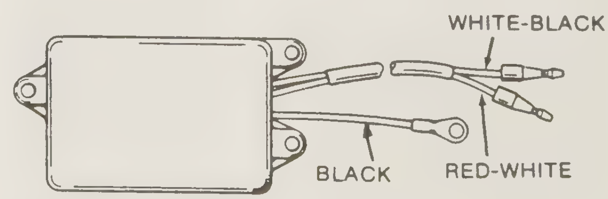
The **ONLY** method to determine which "black box" is installed on the powerhead being serviced is to make an identification of the wires from the "black box" to the switch boxes as follows:

Idle Stabilizer (2 mounting screws Type 1)	White/Black Red/White Black
Idle Stabilizer (3 mounting screws Type 2)	White/Black Red/White Black
High Speed Spark Advance Module (2 mounting screws)	Black White/Black Green/White Red/White
Low Speed/High Speed Spark Advance Module (3 mounting screws)	Red/White Black White/Black

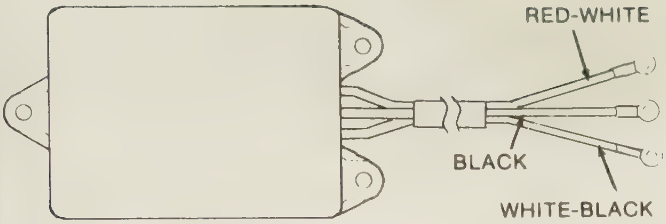
"BLACK BOX" OPERATION

Idle Stabilizer will electronically advance the timing by as much as 9° if the idle speed falls below 550 rpm.

High Speed Spark Advance Module will advance the timing by 6° when the powerhead rpm reaches 5600. The timing will remain advanced until powerhead rpm drops to 5400. At this speed, the module will retard the timing by 6°.



Color coding for the idle stablizer "black box" module. The "black box" cannot be serviced.



Color coding for the low speed/high speed spark advance "black box" module.

Low Speed/High Speed Spark Advance will affect both idle and high speed powerhead operation by advancing the spark at idle and high speed.

CRITICAL WORDS ALL MODELS

When timing the powerhead using the cranking motor, the White/Black wire from the idle stabilizer or the low speed/high speed spark advance module **MUST** be **DISCONNECTED** from the switch box and the end taped off with insulating tape. If this wire is not disconnected, there is no way on this green earth to properly time the powerhead.

TROUBLESHOOTING "BLACK BOX" MODULES

To determine if a module is functioning properly, a timing light must be connected to the No. 1 (top starboard bank) spark plug lead. A tachometer **MUST** also be connected either directly to the powerhead or through the remote control unit.

Start and operate the powerhead until it reaches normal running temperature.

SPECIAL WORDS

Because the individual modules and the tachometer have a sensitivity variance, the affected rpm may vary slightly from the stated rpm speeds.

Idle Stabilizer Module

Allow the powerhead to idle above 600 rpm, then retard the ignition timing by slowly pulling forward on the spark lever arm. If the system is functioning properly a rapid spark advance, perhaps 9° from the idle setting, should be noted, as the powerhead slows to below about 550 rpm.

As mentioned at the beginning of this section, the module is a sealed "black box" and cannot be opened or repaired. If the unit is defective, it **MUST** be replaced.

High Speed Spark Advance Module

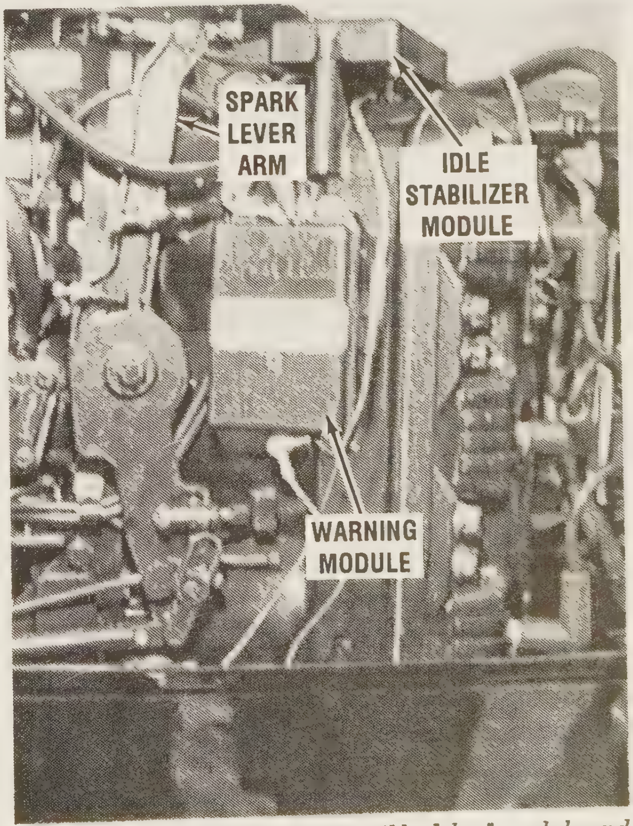
Slowly advance the throttle to above 5600 rpm and at the same time observe the timing. The timing should advance about 6° at approximately 5600 rpm. Now, decrease powerhead speed to about 5400 rpm and at the same time observe the timing. The timing should retard about 6°.

As mentioned at the beginning of this section, the module is a sealed "black box" and cannot be opened or repaired. If the unit is defective, it **MUST** be replaced.

Low Speed/High Speed Spark Advance Module

Low Speed Function

Allow the powerhead to idle above 600 rpm, then retard the ignition timing by slowly pulling forward on the spark lever arm. If the system is functioning properly a rapid spark advance, perhaps 9° from the idle setting, should be noted, as the powerhead slows to below about 550 rpm.



Location of the idle stabilizer "black box" module and the spark lever arm, mentioned in the text. Other adjustment points are clearly visible.

High Speed Function

If servicing an XR4/Magnum II, 175 XRi/Magnum EFI, or 200 HP with carburetor unit, proceed as follows:

Slowly advance the throttle to above 5000 rpm and at the same time observe the timing, with the timing light. The timing should advance by about 6° to 26° BTDC, until the powerhead speed is lowered to below 5600 rpm.

As mentioned at the beginning of this section, the module is a sealed "black box" and cannot be opened or repaired. If either function of the unit is defective, it **MUST** be replaced.

Idle Stabilizer Shift System

The idle stabilizer shift system is normally installed only on the 150XR6 and Magnum III models with a high pitch propeller installed.

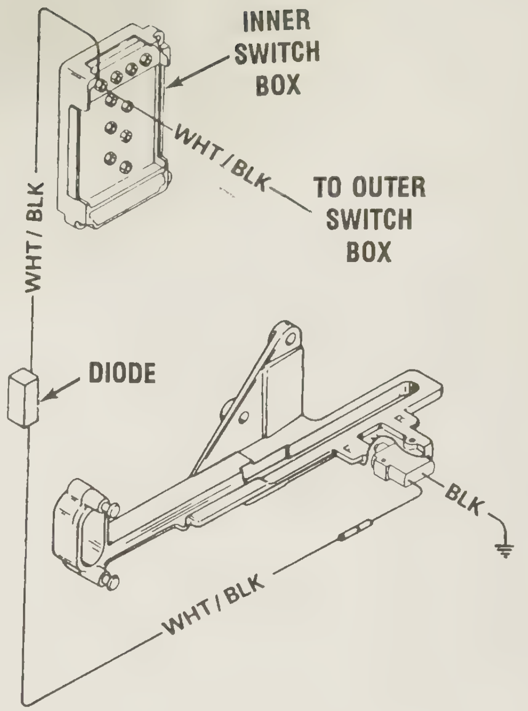
The idle stabilizer shift system is designed to increase idle timing 3° when shifting from neutral to forward gear. This increase in idle timing prevents the outboard, with a high pitch propeller installed, from stalling after shifting into forward gear . This system may be added to any V-6 powerhead as an accessory kit. When the idle stabilizer shift kit is installed, be sure to retard the maximum advance timing three degrees to offset the three degree advance at idle.

Functional Testing of the Idle Stabilization Shift System

To determine if the idle stabilization shift system is operating properly, a timing light must be connected to the No. 1 (top starboard bank), spark plug lead.

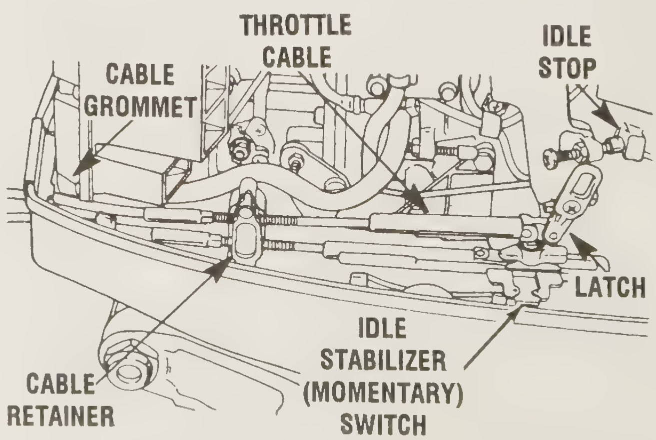
Connect a flush device to the lower unit **NEVER** operate the powerhead over 1000 rpm with a flush device attached, because the engine may "**RUNAWAY**" due to the no load condition on the propeller. A "runaway" engine could be severely damaged.

Start the powerhead and allow it to idle to normal temperature and idle speed. Monitor the "idle timing" with the timing light and shift the outboard into forward gear. The timing should advance three degrees from the indicated timing in neutral. This would indicate the system is operating satisfactory.



Very simple line drawing to depict the idle stabilizer shift system, described in the text.

If the timing did not advance, disconnect the Black/White wire lead from the shift switch on the shifter bracket. Momentarily, hold the Black/White lead to good ground on the powerhead while monitoring the idle timing. If the timing advances three degrees, replace the defective shift switch. If the timing does **NOT** advance, the 6.8K resistor in the wire lead from the switch box is bad and **MUST** be replaced. If the resistor is left shorted to ground, this will allow the powerhead timing to be over advanced causing detonation and damaging the powerhead.



Line drawing showing the idle stablizer shift system installed. Other items are "called out".

5-5 COMPUTER CONTROLLED MODULAR ECU IGNITION SYSTEM MODEL 225HP -- 1994 AND ON

Description

This ignition system is a combination of an alternator driven capacitor discharge (CD), system and an Electronic Control Unit (ECU) system. The CD system generates voltage to fire the spark plugs. The electronic control unit provides ignition timing. The ECU also controls the following functions: ignition timing, idle stabilization, fuel enrichment, overheat warning and low oil quantity warning. The ECU "black box" is an expensive module replacing sometimes as many as nine "black box" modules in a conventionaL CD ignition system.

The electronic control unit (ECU) monitors signals from powerhead mounted sensors. These sensors provide information to the computer within the ECU. The ECU is then able to provide a total of seven functions during outboard operation as described in the following paragraphs.

Spark Timing

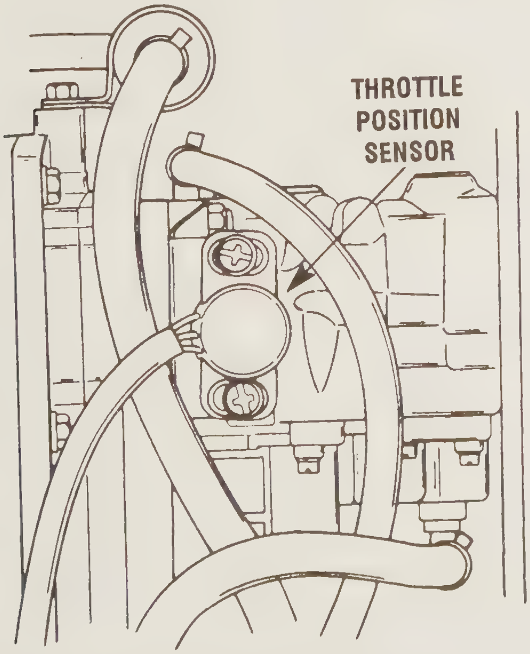
The ECU controls the spark timing during normal operation by monitoring powerhead rpm, carburetor throttle shutter opening and powerhead operating temperature. As the throttle is advanced, timing is also advanced for the specific powerhead rpm and operating temperature. A crank position sensor mounted below the flywheel ring gear monitors powerhead rpm. A throttle position indicator sensor mounted on the top carburetor throttle shutter. A powerhead temperature sensor mounted in the starboard cylinder head monitors powerhead temperature.

Fuel Mixture

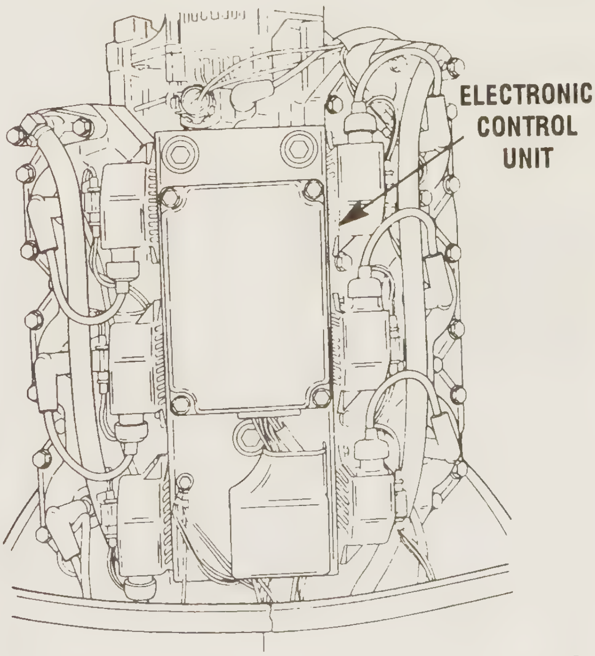
During powerhead cold start-up, the ECU advances the spark timing and opens the fuel enrichment valve to provide a rich fuel mixture. When the key switch is released to the **RUN** position, the fuel enrichment valve is closed, but advanced timing continues until the cylinder head temperature reaches 146° F (60° C). Advanced timing will also continue when powerhead speed is above 3000 rpm.

Overspeed Protection

While the powerhead is operating, the ECU provides overspeed protection should powerhead speed exceed 6,000 rpm. Actually, overspeed protection is accomplished in two stages. Initial powerhead timing is gradually retarded to hold powerhead speed to 5900 rpm. If powerhead speed is rapidly advanced to 6400 rpm, the ECU will quickly retard timing as much as 2° ATDC preventing any additional increase in rpm.



Location of the throttle position sensor -- a part of the electronic control unit (ECU).



The ECU unit is mounted on the aft portion of the powerhead. The unit cannot be serviced and is expensive.

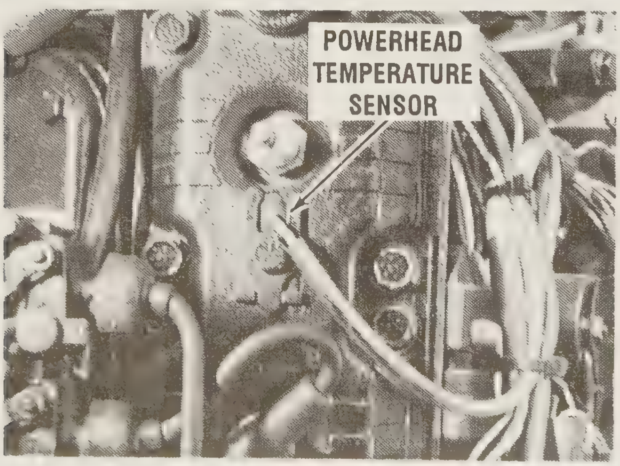
A sudden increase in powerhead speed might be caused by any one of several conditions. One example would be the propeller breaking out of the water when the boat is operated during heavy weather in rough water. When an overspeed condition does occur, the ECU will trigger a warning signal consisting of both the low-oil quantity and overheat lamps flashing alternately simultaneously with the warning horn sounding.

Low Oil and Overheat

The ECU monitors low oil quantity and overheating conditions. When the switch, mounted in the engine oil tank, is closed for more than 30 seconds, the ECU will cause the low oil warning lamp to illuminate and the warning horn to sound. The warning horn will emit 4 short beeps per second, pause for two minutes and then repeat the warning sequence again until the oil tank is serviced or the key switch is turned to the **OFF** position.

Powerhead Temperature

Powerhead temperature is constantly monitored by the ECU during operation. If an overheat condition should develop, the ECU performs two very important functions. First, the ECU causes a visual and audible overheat warning to the helmsperson. The second function is to limit powerhead rpm by retarding ignition timing. When powerhead temperature rises above 200° F (93.3° C), the overheat warning lamp will illuminate and the warning horn will emit a continuous tone. At the same time, the ignition timing will be retarded to limit engine speed to a maximum of 3000 rpm. When powerhead temperature drops below 190° F (87.8° C), the overheat warning light will go out and the horn will silence. Normal ignition timing will resume.



Location of the powerhead temperature sensor -- just below the No. 1 spark plug.

Idle RPM

During powerhead operation at idle speed, the ECU monitors the idle rpm and provides idle stabilization. If the idle rpm is too low, the ECU will advance ignition timing to increase powerhead rpm up to the normal rpm range. A maximum of 6° advanced timing will occur around 450 rpm.

Internal Diagnostic Checks

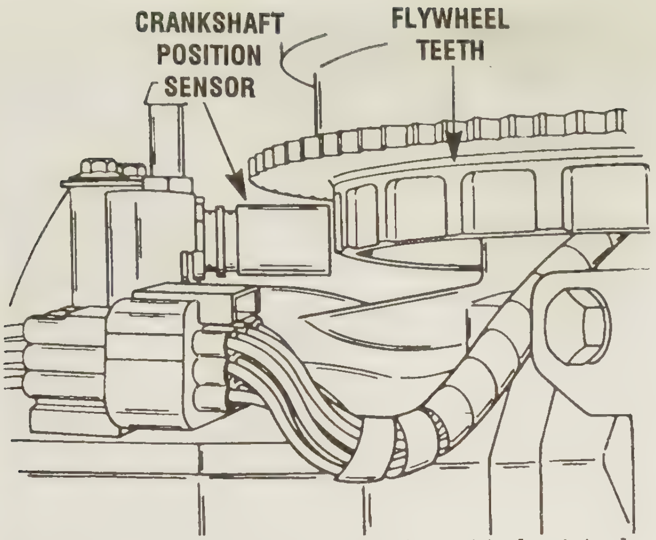
The ECU performs constant internal diagnostic checks. The throttle position sensor and powerhead temperature sensor operation are extremely important to ECU operation. If either sensor fails, within 15 seconds following the failure, the ECU will cause the low oil quantity and overheat warning lights to flash alternately. The warning horn will also be activated. This visual and audible warning will continue until the key switch is turned to the **OFF** position.

Theory of Operation

The ignition sequence begins as the permanent magnets in the flywheel rim pass the stator. On the stator are six charging bobbins, one bobbin is used for each cylinder. The stator performs two functions, the primary function is to produce an AC voltage for each of the ignition modules. Secondary function of the stator is to act as a trigger in the event of an ECU failure. If the ECU were to fail, the stator will trigger the spark to each cylinder. Ignition timing is limited to 9° ATDC, therefore power would be low, but the engine will continue to operate.

Voltage Charge

The ignition module rectifies and stores the voltage charge from the stator bobbin. An amplifier circuit within the module boosts the voltage to approximately 45,000 volts at the spark plug. Normally, the ignition module receives a triggering signal from the ECU. The stored voltage charge within the ECU is released through the coil windings of the ignition module to the spark plug. As mentioned earli-



The crankshaft position sensor is a critical unit in the ECU system, as explained in the text.

er, in the event of an ECU failure, the stator will provide the trigger signal to each ignition module.

Crankshaft Position and Crankshaft Speed

Accurate crankshaft position (angle), and speed are critical to efficient ECU operation. The crank position sensor is mounted on top of the powerhead next to the flywheel.The outside rim of the flywheel contains 22 teeth. As the teeth pass through the magnetic field of the crank position sensor, a pulsed signal is sent to the ECU. These signals provide the ECU with accurate powerhead rpm and crankshaft position (angle) in order to fire the next corresponding cylinder spark plug.

When the powerhead is accelerated, ignition timing must be advanced in order to achieve the maximum power and performance from the powerhead. Other outboard models use a mechanical linkage arm from the throttle lever to the trigger assembly.

Because this model does not have a trigger assembly, timing is a combined function of the throttle position sensor, crankshaft position sensor and the powerhead temperature sensor. When the throttle is advanced, the throttle position sensor sends a signal to the ECU. The ECU combines this signal with the crankshaft position sensor and with the powerhead temperature signals. From this source of operating information, the ECU determines the best timing advancement. The timing advancement is accomplished by triggering the ignition module to fire early or late, thus advancing or retarding ignition timing.

The powerhead temperature sensor plays a critical role in ignition timing. During cold start-up, the temperature sensor causes the ECU to activate the fuel enrichment valve. If an over heat condition should arise, the temperature sensor causes the ECU to retard the ignition timing to prevent spark knock or other internal powerhead damage caused by pre-ignition.

TROUBLESHOOTING COMPUTER CONTROLLED ECU IGNITION SYSTEM

READ, BELIEVE, & OBEY

Never touch or disconnect any ignition components on a powerhead equipped with the computer controlled ignition system while the powerhead is running, the key switch is **ON**, or while the battery cables are connected, because very high voltage is present.

The following safety precautions are listed for personal safety and to prevent damage to expensive parts.

> **NEVER** reverse battery cable connections. The battery negative (-) is ground. The black cable must always be connected to this terminal. The red cable must always be connected to the positive (+) terminal.
> **NEVER** check polarity by "sparking" the battery terminals with the battery cable.
> **NEVER** disconnect the battery cables while the powerhead is running.
> **NEVER** crank the powerhead if components have been disconnected or are not properly grounded to the powerhead.

The ECU, stator, crankshaft position sensor and throttle position sensor are all sealed units and cannot be serviced internally. If troubleshooting indicates one of these components has failed, the unit **MUST** be replaced as an assembly.

Use **ONLY** a **Digital Meter** while performing the troubleshooting tests. The use of an analog test meter will certainly damage internal devices on some of the ignition system components.

ALWAYS check the following areas for source of trouble **BEFORE** testing ignition components.

Check to be sure all ground connections are tight and free of corrosion. Check the mercury "tilt switch". Many times, this switch is the source of the problem.

Verify all plug-in electrical connectors in the ignition system harness are fully engaged by disconnecting and connecting them back together. Examine the plug for corrosion around the connector pins..

Check to be sure all electrical components and/or ground wires are properly grounded to the powerhead. Examine the entire electrical system for disconnected or damaged wiring.

Ready For Troubleshooting

Always attempt to proceed with the troubleshooting in an orderly manner. The "shot in the dark" approach will only result in wasted time, incorrect diagnosis, replacement of unnecessary parts, and frustration.

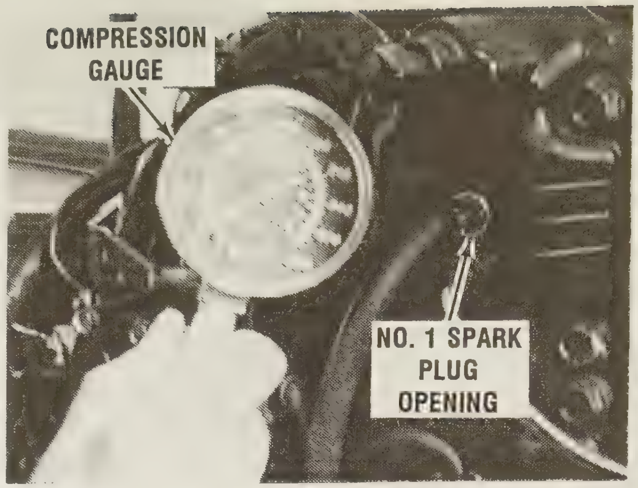
Begin the ignition system troubleshooting with the spark plugs and continue throughout the system until the source of the trouble is located.

Spark Plugs

1- Check the spark plug high tension leads to be sure they are properly connected. Check the entire length of the lead from the plug to the ignition module coil. If the lead is to be removed from the spark plug, **ALWAYS** use a pulling and twisting motion as a precaution against damaging the connection.

2- Attempt to remove the spark plug by hand. This is a rough test to determine if the plug is tightened properly. You should not be able to remove the plug without using the proper size socket tool. Remove the spark plugs and keep them in order. Examine each plug and evaluate its condition as described in Section 5-2.

3- Use a spark tester and check for spark at each cylinder. If a spark tester is not available, hold the plug wire about 1/4" inch from the powerhead using insulated pliers. Have an assistant rotate the flywheel with the emergency starter rope wrapped around the flywheel or with the cranking motor. A strong spark over a wide gap must be observed when testing in this manner, because under compression a strong spark is necessary in order to ignite the air/fuel mixture in the cylinder. This means it is possible to think a strong spark is present, when in reality the spark will be too weak when the plug is installed. If there is no spark, or if the spark is weak on one cylinder, the trouble is most likely in the ignition module for the weak cylinder.



A compression gauge with the hose threaded into the No. 1 spark plug opening in preparation to making a compression check. Each cylinder must be checked.

Compression

4- Before spending too much time and money attempting to trace a problem to the ignition system, a compression check of each cylinder should be made. If the cylinder does not have adequate compression, troubleshooting and attempted service of the ignition and fuel systems will fail to give satisfactory powerhead performance.

Remove the spark plug leads by pulling and twisting **ONLY** on the molded cap. **NEVER** pull on the wire because the connection inside the cap may be separated or the boot damaged. Remove all spark plugs from the powerhead. Starting at the No. 1 cylinder, insert a compression gauge into the cylinder spark plug opening. Have an assistant crank the powerhead through several flywheel revolutions and note the compression reading. Repeat this procedure for each cylinder.

The manufacturer refuses to give a specific acceptable compression reading for any of their powerheads from the single cylinder units to the V6 and V8 units. A general figure might be in the neighborhood of 125 psi for a V6 powerhead. A variation in reading between the cylinders is far more important than the actual individual readings. If a particular cylinder varies more than 15 psi from the others, the cylinder may be scored, the rings frozen, or the piston burned. Mercury/Mariner V-6 powerheads use cylinder heads on each bank of cylinders. Therefore, low compression on two cylinders next to each other could also be attributed to a blown head gasket or sealing ring. If a cylinder is low on compression, correct the compression problem first, before continuing with the ignition system testing.

COMPUTER CONTROLLED MODULAR C.D. IGNITION SYSTEM - TROUBLESHOOTING

ENGINE MALFUNCTION	CORRECTIVE ACTIONS
No spark to all cylinders	Check the ignition stop lead Black\Yellow wire from the Key Switch to the engine harness for a short to ground. Check the Ignition Stator Harness connector is connected.
Weak spark to all cylinders.	Check for high resistance on the ignition stop lead Black\Yellow wire. Check for broken insulation on the wire or other damage.
No spark or a weak spark to one cylinder.	Check the Ignition Module, Stator Bobbin and wiring between for the effected cylinder.
Ignition Timing fluctuates. See Note 1	Loose or poor ground connections. Crankshaft Position Sensor air gap is not properly set or the sensor is defective. The Throttle Position Sensor, Engine Temperature Sensor or the ECU is defective.
Timing does not advance on all cylinders.	Crankshaft Position Sensor has failed. Power to the ECU (12VDC) is OFF, check wiring to powerhead terminal block. The Throttle Position Sensor or the ECU is defective.
Timing will not advance on one or more cylinders.	Check for defective or damaged wiring between the Ignition Module and the ECU on cylinders without timing advancement. If wiring checks good, replace the Ignition Module on cylinder bank without timing advancement.
Engine misfires at high rpm.	Alternator Red output lead is loose, check connectors. Defective Ignition Module, Crank Position Sensor or the ECU is defective.
Engine hard to START when cold.	Defective Enrichment Solenoid Valve, Engine Temperature Sensor, Crank Position Sensor or the ECU.
Engine misfires in the low rpm range, but runs smooth in high rpm range.	Loose harness wire connections between ECU and the Ignition Modules. Defective Ignition Module.
Engine is hard to start at normal operating temperature.	Defective Fuel Enrichment Valve or Crank Position Sensor.
Engine will not accellerate over 3,000 rpm, temperature is normal, NO overheat warning indication.	Defective Engine Temperature Sensor, Throttle Position Sensor or ECU.

NOTE 1: Timing fluctuation of 2 degrees @ idle speed is normal. If powerhead temperature is above 200 degrees F sensor will limit rpm to 3000. If the engine rpm exceeds 6,000 rpm, the over rev circuit in the ECU will retard timing to reduce rpm.

Troubleshooting - Computer Controlled Ignition System

There are several ways to begin the troubleshooting of a particular ignition system. The table provided is set-up in the most logical sequence of failures. Begin by looking in the **PROBLEM** column for the action that best describes the problem with the outboard being serviced. Move across to the **CORRECTION** column. Perform the corrective actions listed for the particular problem.

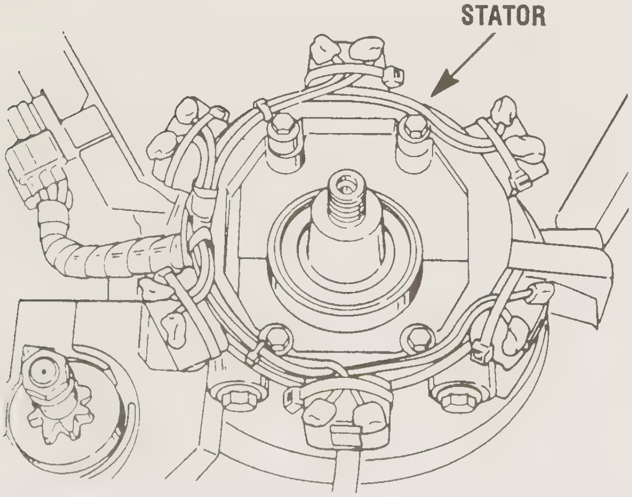
When the correction column indicates a component is suspected to have failed, individual test are provided to determine if the item has failed. When a component fails, a new one will have to be purchased to place the outboard back into operation.

Stator Testing

The stator may be tested by performing either a partial dynamic (using only the cranking motor), voltage test or a static ohms test. **DO NOT** operate the powerhead while performing either test.

Stator Ohms Test

The stator ohms test may be performed with the stator installed on the powerhead. Remove the flywheel as described in Chapter 8. Disconnect the stator plug connector. Using a digital multimeter, set the meter for Rx100 ohms scale. Connect the two meter leads (Red and Black) to the two wires from each stator bobbin coil. The meter should indicate between 680 to 710 ohms ± 10% at each bobbin coil. If any bobbin coil is defective, replace the stator assembly.



The stator ohm test may be performed while the unit remains in place on the powerhead.

Stator Voltage Test

This test will verify the correct output voltage for each of the bobbin coils while the powerhead is being cranked with the cranking motor. Remove the spark plug from all cylinders. Connect a grounding clip from each high tension lead boot to a good ground on the powerhead. Set the digital multimeter for 100 VAC reading. Connect the meter leads to the pair of color coded leads listed below for each cylinder. With the meter connected to the bobbin leads, crank the powerhead with the cranking motor and observe the meter. The multimeter should indicate 70 - 75 VAC at cranking speed. If any bobbin coil is defective, replace the stator assembly.

Cylinder	Color
#1	White/Blue Green/Blue
#2	White/Orange Green/Orange
#3	White/Black Green/Black
#4	White/Red Green/Red
#5	White/Yellow Green/Yellow
#6	White/Green Green

Crankshaft Position Sensor Test

Disconnect the crankshaft position sensor wire harness lead from the plug connector. Set the digital multimeter to Rx1,000 ohms. Connect the digital multimeter leads to the two wire leads on the back of the sensor. The multimeter should indicate 900-1,300 ohms. If the sensor does not indicate an adequate ohms reading, replace the crankshaft position sensor.

Throttle Position Sensor Test

This test **MUST** be performed with a Digital Multimeter and a sensor test adapter (P/N 84-822560A1) connected between the TPI sensor

and the ignition harness. Connect the sensor test adapter between the TPI connector and the ignition harness. Set the digital multimeter to the 10 VDC scale. Place the throttle in the idle position with the idle stop screw against the idle stop.

Place the ignition key switch to the **ON** position but **DO NOT START** the powerhead. The meter should indicate .950± .050 VDC. Slowly move the throttle from idle to the wide open throttle (WOT) position. The voltage increase on the meter should be smooth, without any erratic "up or down" jumps. Hold the throttle in the WOT position. The meter should indicate 3.86± .050 VDC or higher. If the meter does not register within the above range, replace the TPI sensor.

Electronic Control Unit -- ECU Test

Mount the outboard unit in a test tank or the boat in a body of water. This test requires the outboard to be operated above idle speed. Therefore, a flush attachment **CANNOT** be used. Remove or open the powerhead cowling. Connect a timing light to the No. 1 spark plug high tension lead. Start the powerhead.

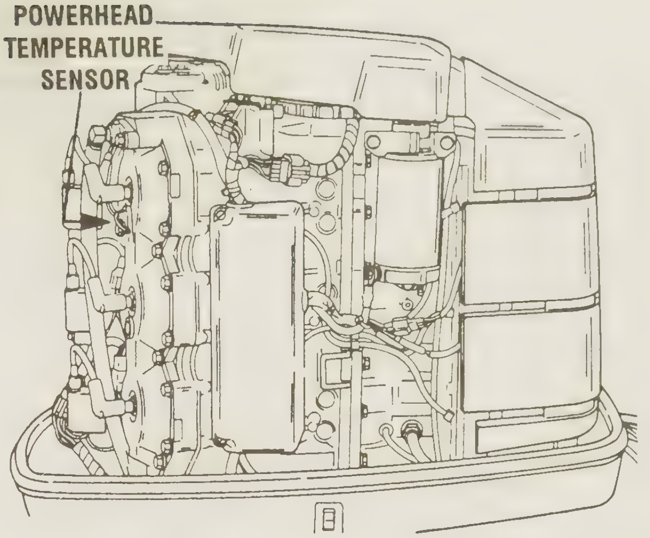
CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Slowly advance the throttle to 3500 rpm while aiming the timing light towards the timing marks on the flywheel. Verify the timing advances as the throttle is moved, and then return the throttle to the idle position. Disconnect the timing light from No. 1 spark plug lead and connect the light to No. 2 lead. Repeat the test until all cylinders have been checked for timing advancement. It is possible for the ECU to **NOT** advance the timing on one or more cylinders. Therefore, this test **MUST BE** performed on all cylinders. If the timing advances, retards, and all cylinders are firing, the ECU is working properly.

Engine Temperature Sensor

The engine temperature sensor can have a direct affect on ECU and powerhead timing. If the sensor is suspected of being defective, remove the sensor from the powerhead and



Line drawing to indicate location of the powerhead temperature sensor -- just below the No. 1 spark plug.

perform the following ohms test with the sensor suspended in a liquid.

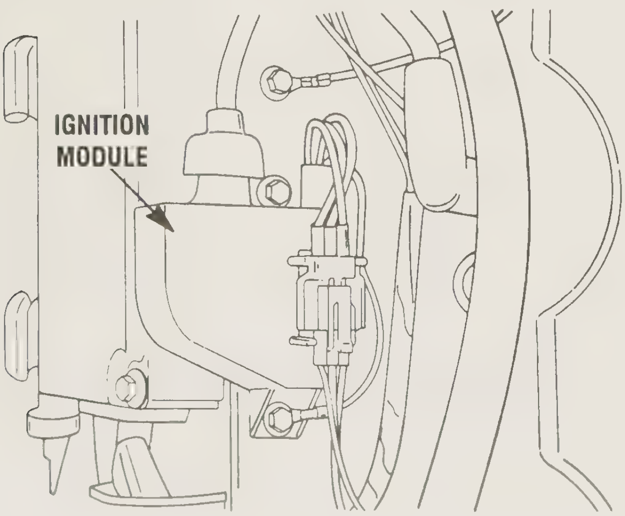
Suspend the temperature sensor in a container of water along with a thermometer. Set a digital multimeter to the Rx1000 scale. Connect the multimeter leads to the two Tan sensor leads. Using ice and/or heat, change the temperature of the water and compare the thermometer readings to the resistance column in

WATER TEMPERATURE F⁰	RESISTANCE OHMS
32	3287
41	2551
50	1996
59	1574
68	1250
77	1000
86	805
95	652
104	532
113	436
122	360
131	298
140	248
149	208
158	175
167	148
176	126
185	107
194	92
203	79
212	68
221	59

C. D. IGNITION SYSTEM WITH E.C.U.

IGNITION MODULE CHECKS					
MODEL	YEAR	MULTIMETER LEADS	CONNECTED TO:	METER SCALE SETTING	ALLOWABLE METER LIMITS
225	1994 and On	RED BLACK	Ground White	R x 1	40 +/- 10 OHMS
		RED BLACK	Green/White Ground	R x 1	Continuity
		RED BLACK	Ground Green/White	R x 1K	No Continuity
		RED BLACK	Green/White Black/Yellow	R x 1K	No Continuity
		RED BLACK	Black/Yellow Green/White	R x 1	Continuity
		RED BLACK	Coil Tower Ground	R x 10	1000 +/- 300 OHMS

the table and the resistance indicated on the multimeter. Make several temperature/resistance cross checks to verify the temperature sensor is acceptable or defective. Note how the resistance of the sensor rises as the water is cooled, and when the temperature of the water is heated and the temperature rises, the resistance decreases. Replace the temperature sensor if the resistance is not within 10% of the indicated temperatures.



The ignition module cannot be serviced and must be replaced if the test results are not satisfactory.

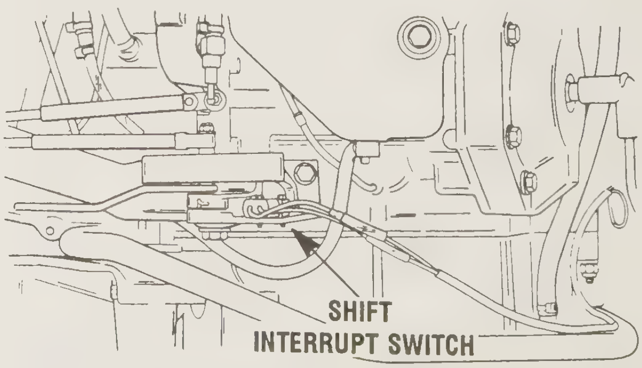
Ignition Module Test

FIRST, these words: A digital multimeter is only capable of detecting certain faults in an ignition module. Replace the module, if the meter readings are not as specified in the accompanying chart.

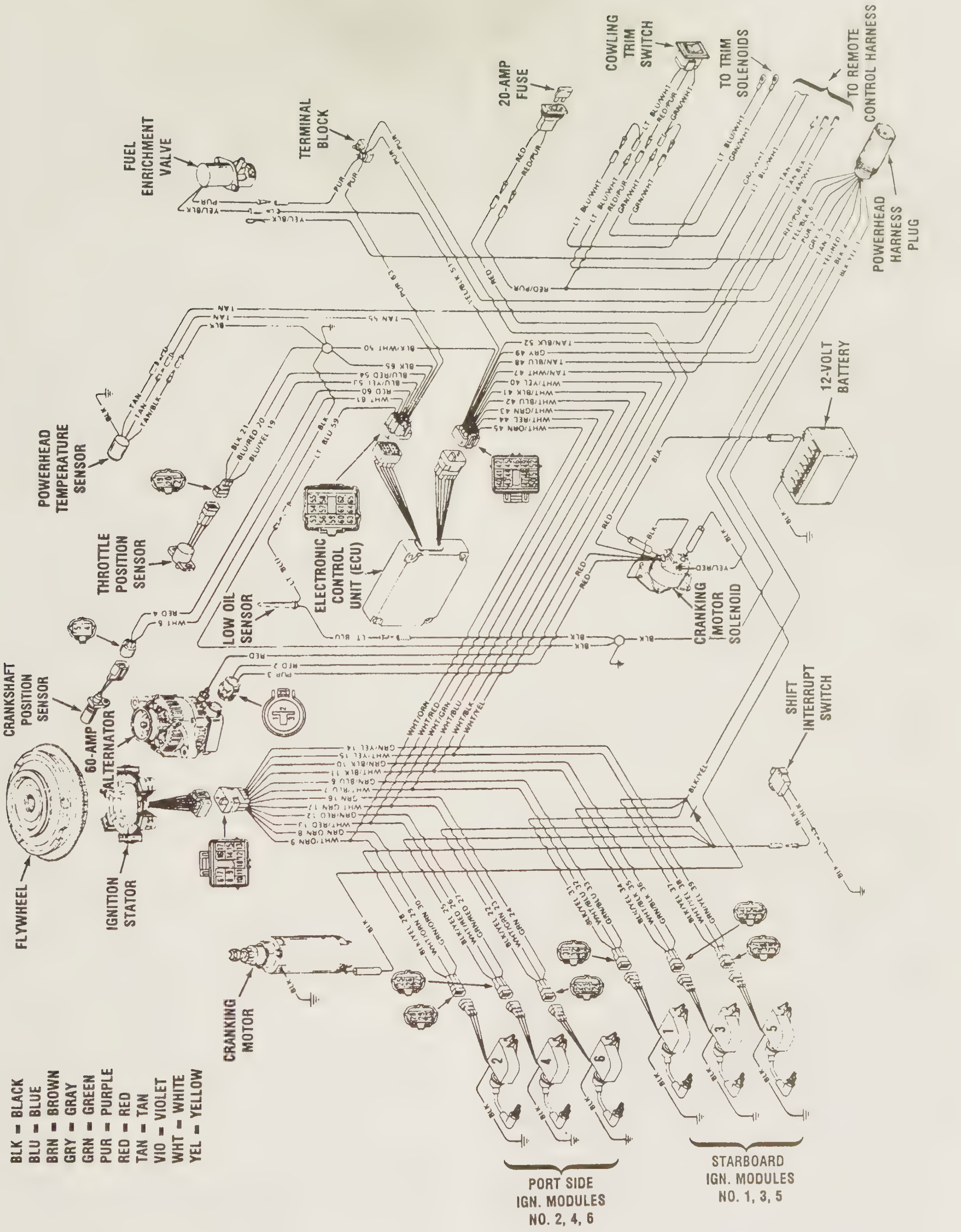
Set the digital multimeter to the Rx1 scale. Connect the meter test leads to the color wires indicated in the chart. If the meter reading is not as indicated in the chart, the ignition module is defective and **MUST** be replaced with a new unit.

Shift Interrupt Switch

The shift interrupt switch is activated by the shift lever and is designed to momentarily



*The shift interrupt switch **MOMENTARILY** grounds the ignition modules for No. 2, No. 4, and No. 6 cylinders when the outboard is shifted from either forward or reverse into neutral.*



Functional wiring diagram of the modular ECU (Electronic Control Unit) covered in this section. Wiring color code is given (even though the type is small), and major electrical components of the system have been identified.

ground the ignition modules from the ignition cycle when shifting from **FORWARD** or **REVERSE** gear into **NEUTRAL**. A diode placed within the shift interrupt switch wiring harness prevents all six modules from being grounded. However, three ignition modules on cylinders #2, #4 and #6 in the port bank **WILL BE** grounded when the interrupt switch is activated by the shift lever. The loss of three cylinders reduces the torque load on the sliding clutch in the lower unit, thus allowing the gear housing to be shifted into **NEUTRAL** with minimum effort.

If considerable effort is required to shift the unit into neutral, or the outboard shuts down when shifted into neutral, perform the following test of the diode:

Disconnect the Black/Yellow wire lead bullet connector on the shift interrupt switch. Set the digital multimeter to Rx1 scale. Insert one meter test lead into the female connector of the shift interrupt switch. Insert the other meter test lead into pin #1 of the powerhead harness connector. Check the meter and observe the indication. Reverse the ohm meter test lead connections and again observe the meter indication. The system is functioning correctly if continuity is indicated in one direction and **NO** continuity is indicated in the opposite direction.

BAD NEWS

If results of the shift interrupt switch test are not satisfactory, the powerhead wiring harness **MUST** be replaced. The diode is an integral part of the wiring harness and is not a serviceable part. If the shift interrupt system is disconnected, with continued operation of the outboard, severe damage to the lower unit will result.

6
TIMING AND SYNCHRONIZING

6-1 INTRODUCTION AND PREPARATION

Timing and the synchronization on a multicylinder outboard powerhead is extremely important to obtain maximum efficiency. The powerhead cannot perform properly and produce its designed horsepower output if the fuel carburetion and ignition systems have not been precisely adjusted.

Synchronization

In simple terms, synchronization is timing the carburetion to the ignition. This means, as the throttle is advanced to increase powerhead rpm, the carburetor and the ignition systems are both advanced equally and at the same rate.

Therefore, anytime the fuel system or the ignition system on a powerhead is serviced to replace a faulty part, or any adjustments are made for any reason, powerhead timing and synchronization **MUST** be carefully checked and verified.

For this reason the timing and synchronizing procedures have been separated from all others and presented alone in this chapter.

Before making adjustments with the timing or synchronizing, the ignition system should be thoroughly checked according to the procedures outlined in Chapter 5, and the fuel system in good working order per Chapter 4.

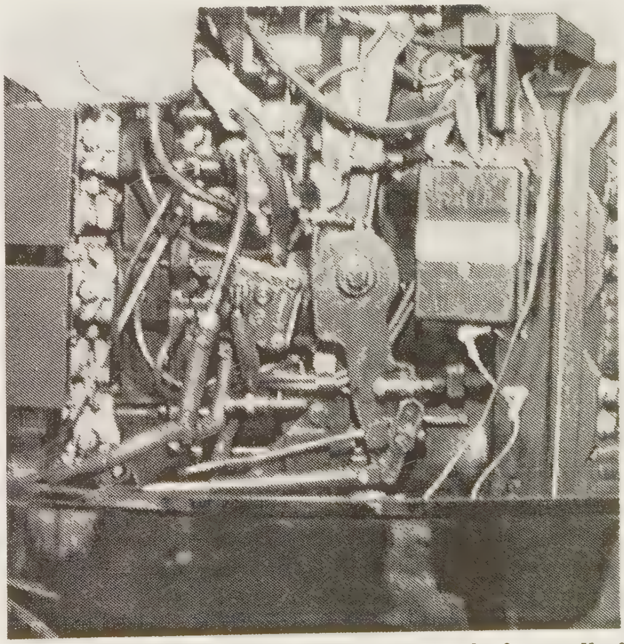
Timing

All outboard engines have some type of synchronization between the carburetion and ignition systems.

Many models do not have timing marks on the flywheel and a dial indicator must be used to properly time the powerhead. On later models the flywheel does have a timing mark and the powerhead may be properly timed using a timing light. This method has its disadvantages, because the powerhead must be run at full throttle in forward gear in a test tank, or at full throttle on the boat in a waterway. The problems of roaring across a lake or down the river at full throttle and attempting to check the timing with a light can easily be imagined.

Therefore, the timing light is not too practical a method of timing and synchronizing a large horsepower powerhead if a test tank is not available.

On some late model and larger horsepower units, the timing is checked using a timing light while cranking the powerhead. Using this procedure it is not necessary to



Once the powerhead cowling is removed, almost all of the timing and synchronizing points are visible and easily accessible.

mount the powerhead in a test tank or to move the boat into a body of water. **HOWEVER**, a flush device **MUST** be used and the powerhead **NEVER** operated above 1000 rpm.

PREPARATION

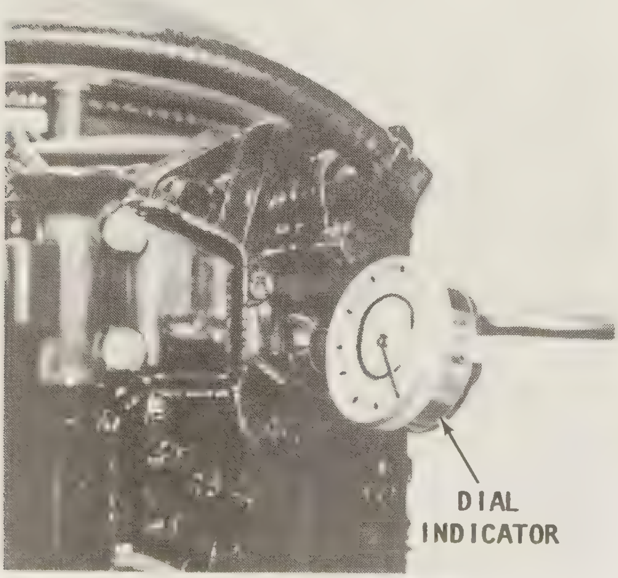
Timing and synchronizing the ignition and fuel systems on an outboard unit are critical adjustments. Therefore, the following equipment is essential and is called out repeatedly in this section. This equipment must be used as described unless otherwise instructed. Naturally, they are removed following completion of the adjustments.

Dial Indicator

Top dead center (TDC) of the No. 1 (top) piston must be precisely known before the timing adjustment can be made. TDC can only be determined through installation of a dial indicator into the No. 1 spark plug opening.

Timing Light

During many procedures in this section, the timing mark on the flywheel must be aligned with a stationary timing mark on the powerhead while the powerhead is being cranked, or is running. Only through use of a timing light connected to the No. 1 spark plug, can the timing mark on the flywheel be observed while the powerhead is operating.



A dial indicator installed into the No.1 spark plug opening is the only accurate method of determining TDC.

Tachometer

A tachometer connected to the powerhead must be used to accurately determine powerhead speed during idle and high speed adjustments.

The meter readings range from 0 to 6,000 rpm in increments of 100 rpm. Tachometers have solid state electronic circuits which eliminates the need for relays or batteries and contributes to their accuracy.

Most marine outboard units have a female plug at the forward end of the shift box as a convenience for installation of a tachometer. Therefore, when purchasing a tachometer, check to be sure the adaptor plug will mate with the fitting on the shift box.

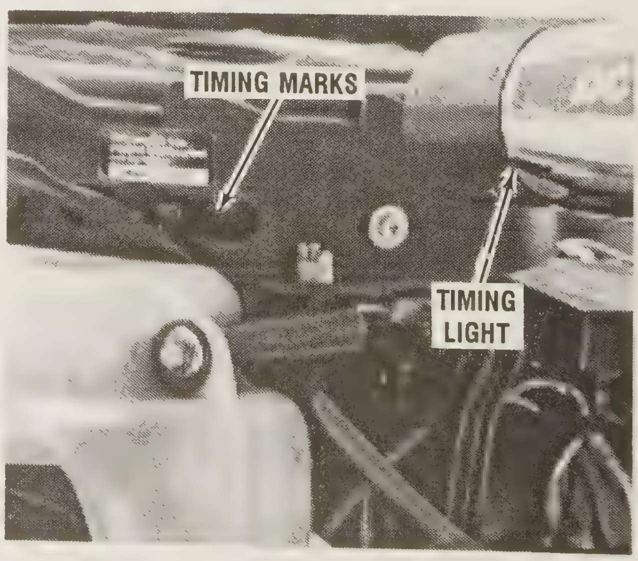
If the boat is not equipped with a tachometer, connect one lead to the primary (negative (-)) terminal of any one coil. Connect the other lead of the tachometer to a good ground on the powerhead.

Test Tank

The powerhead must be operated at various times during the procedures. Therefore, a test tank, flush device, or moving the boat into a body of water, is necessary.

WARNING

The powerhead should NEVER be operated above an idle speed with a flush attachment connected to the lower unit. Operating the powerhead at high rpm could cause the powerhead to "RUNAWAY" from lack of a load causing damage to the unit and possibly injury to personnel in the area.



A timing light aimed at the timing marks on the flywheel and powerhead.

CAUTION: Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

NEVER, AGAIN, NEVER operate the engine at high speed with a flush device attached. The powerhead, operating at high speed with such a device attached, would **RUNAWAY** from lack of a load on the propeller, causing extensive damage.

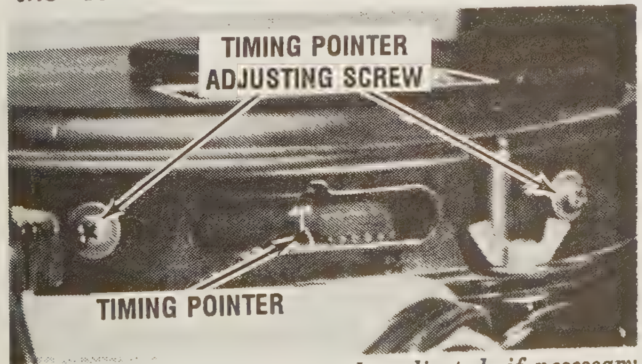
Flywheel Rotation

During the procedures listed in this chapter, the instructions may call for rotating the flywheel until certain marks are aligned with the timing pointer. When the flywheel must be rotated, **ALWAYS** move the flywheel in a **CLOCKWISE** direction, unless instructed to do otherwise. Only in very rare instances will the order be given to rotate the flywheel counterclockwise. When the flywheel is rotated in the opposite direction, the water pump impeller tangs will be twisted backwards. Should the powerhead be started with the pump tangs bent back in the wrong direction, the tangs may not have time to bend in the correct direction before they are damaged. The least amount of damage to the water pump will affect cooling of the powerhead.

Therefore, if the flywheel is ever rotated counterclockwise for any reason, **ALWAYS** rotate the flywheel **CLOCKWISE** manually, to place the water pump vanes in the proper direction **BEFORE** starting the powerhead.

IGNITION TIMING AND CARBURETOR SYNCHRONIZATION

The spark ignites the air/fuel mixture in the combustion chamber at approximately TDC at idle speeds and at a specific number of degrees of advance before TDC at high speeds. These settings will assure maximum efficiency for horsepower and fuel consumption.



The timing pointer may be adjusted, if necessary, through use of the adjusting screws, as described throughout this chapter.

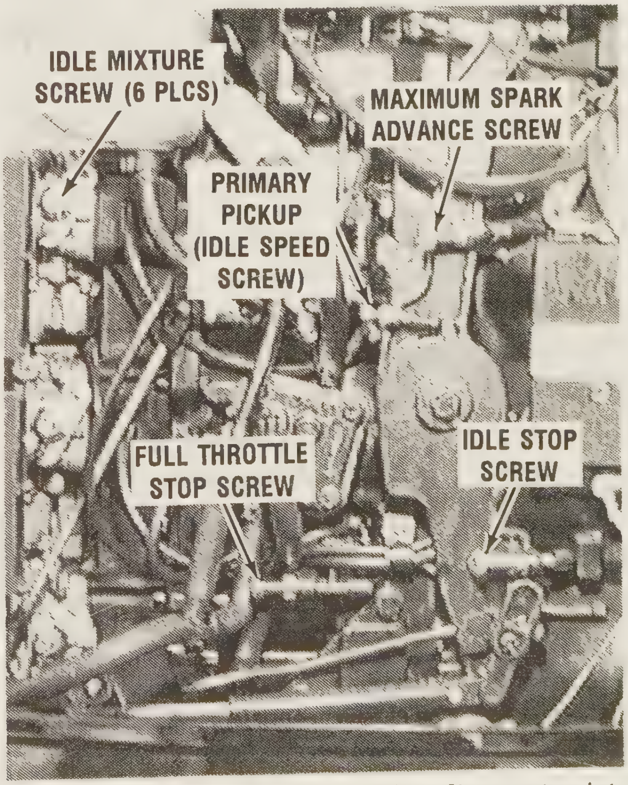
At high speeds, the burning process must start as the piston moves upward in the bore. The burning process will be completed by the time the piston reaches TDC. Maximum combustion chamber pressure will be exerted on the piston dome at TDC to provide the maximum torque and subsequent energy transfer from the cylinder through the drive system to the propeller.

Synchronizing the carburetor with the ignition system ensures the carburetor will provide an increased amount of air/fuel mixture for combustion at increased rpm.

These adjustments are:

Idle mixture
Idle speed
Primary throttle pickup
Maximum spark advance
Full throttle stop adjustment
Secondary pickup adjustment

Not all carburetors installed on the powerheads covered in this manual have all the adjustments listed.



Clear view showing most of the adjustment points listed just above this illustration.

Primary Throttle Pickup Adjustment

The throttle control may be a remote control lever or a throttle twist grip. The control is always connected by linkage to the trigger assembly. When the throttle is advanced to increase powerhead rpm, the trigger coils are also advanced.

This arrangement provides advanced powerhead timing automatically as powerhead rpm increases.

The carburetor **MUST** provide additional fuel as powerhead rpm increases. The throttle plate shutter position in the carburetor bore determines the volume of air/fuel mixture supplied to the combustion chamber.

The throttle pickup adjustment is the preset point of spark advance when the throttle plate shutter **BEGINS** to open.

Idle Mixture Adjustment Operating Principle

As the piston moves upward in the cylinder bore, a suction (negative pressure) draws air through the carburetor throat. The area where the carburetor throat narrows is called the venturi. This reduction in the throat size has the effect of reducing air pressure. Reduction of air pressure increases air speed through the venturi.

A simple example in the outside world, is to consider the increased wind velocity through a mountain pass.

Because of carburetor design, at idle speed, fuel is made available at the top of the idle tube. The incoming air stream mixes with the fuel to form a combustible air/fuel mixture in the correct proportions.

The needle end of the idle adjustment screw may be opened to allow more fuel to enter or closed to restrict the flow of fuel past the top of the idle tube. In this manner the proportion of air/fuel mixture may be altered.

The correct setting of the idle mixture screw will provide an optimum mixture for powerhead operation at idle speed.

The idle mixture screw is **ALWAYS** equipped with a spring to prevent the setting from changing due to vibrations. Some model carburetors will even have limiter caps to prevent large changes in the idle mixture circuit.

The tapered end of the screw must be in good condition to allow fine tuning of the mixture proportions.

A screw which has been excessively tightened will have a "deformed" end and should be replaced.

WO-9 CARBURETORS

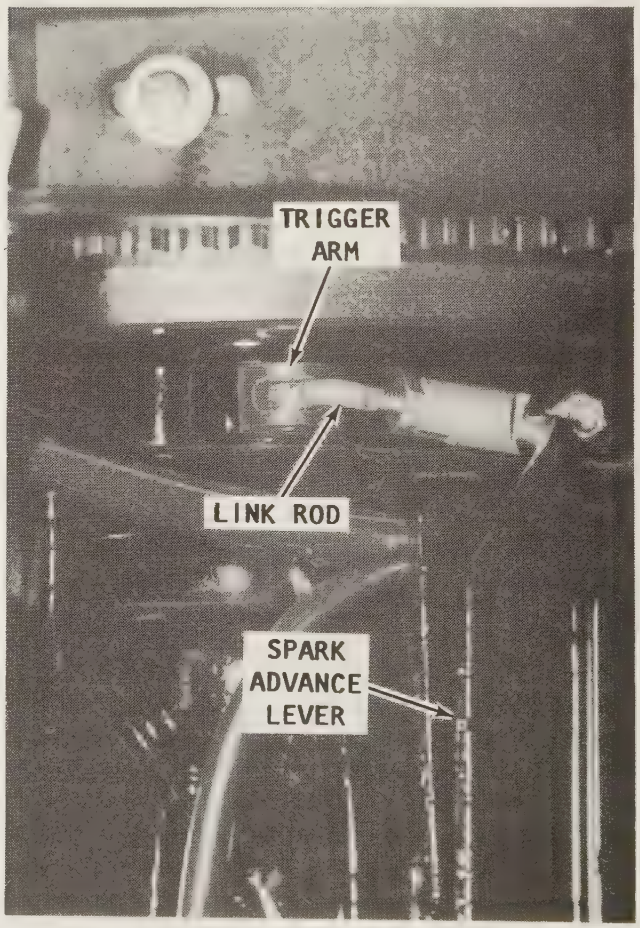
Powerheads equipped with the WO-9 carburetors **DO NOT** have idle mixture screws, but rather idle mixture jets. These jet are easily changed and come in a variety of sizes. Contact the local Mercury/Mariner dealer for size recommendation.

Making Idle Mixture Adjustment

The idle mixture and idle speed are set at the factory. Due to local conditions, it may be necessary to adjust the carburetor while the engine is running in a test tank or with the boat in a body of water. For maximum performance, the idle mixture and the idle rpm should be adjusted under actual operating conditions.

Set the idle mixture screw at the specified number of turns open from a lightly seated position.

Start the powerhead and allow it to warm to operating temperature.



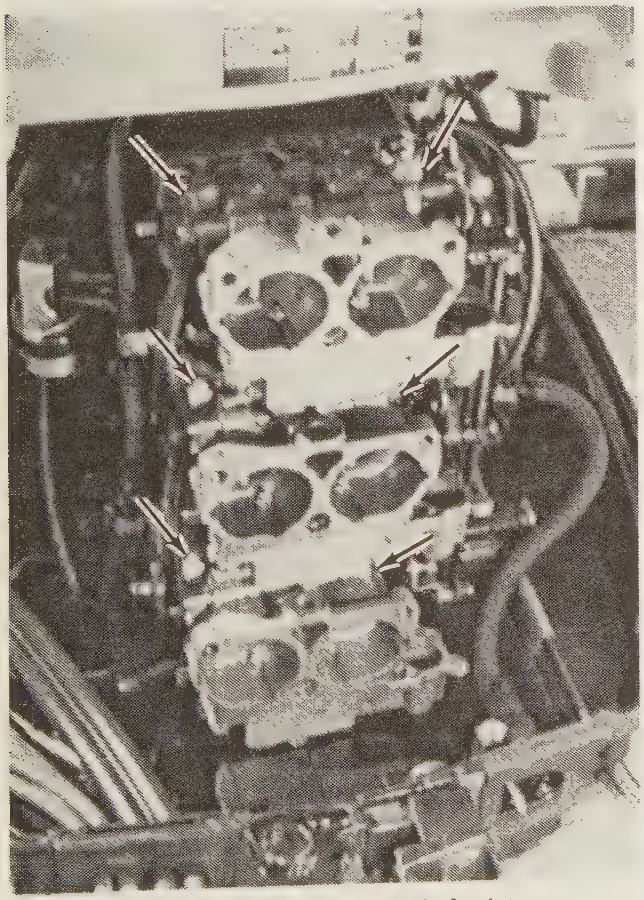
The link rod connecting the spark lever to the trigger under the stator.

CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

NEVER, AGAIN NEVER, operate the powerhead at high speed with a flush device attached. The powerhead operating at high speed with such a device attached, would **RUNAWAY** from lack of a load on the propeller shaft, causing extensive damage.

With the engine running in forward gear, slowly turn the idle mixture screw **COUNTERCLOCKWISE** until the affected cylinders start to load up or fire unevenly, due to an over-rich mixture. Slowly turn the idle mixture screw **CLOCKWISE** until the cylinders fire evenly and engine rpm increases. Continue to slowly turn the screw **CLOCKWISE** until too lean a mixture is obtained and the rpms fall off and the engine begins to misfire. Now, set the idle mixture screw one-quarter (1/4) turn out (counterclockwise) from the lean-out position. This adjustment will result in an approximate true setting. A too-lean setting is a major cause of hard starting a cold engine. It is better to have the adjustment on the rich side rather than on the lean side. Stating it another way, do not make the adjustment any leaner than necessary to obtain a smooth idle.



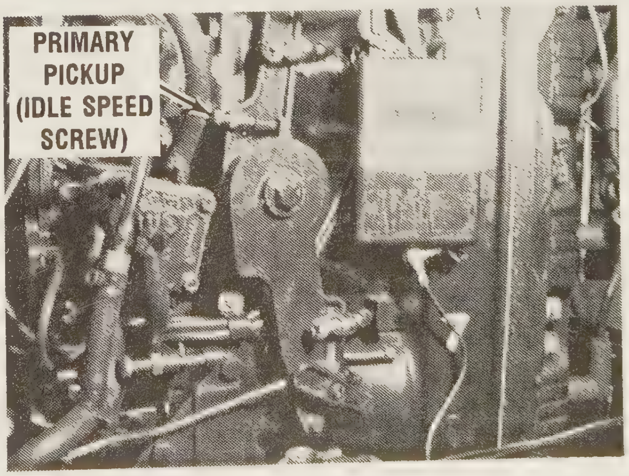
The arrows indicate the six air/fuel mixture screws -- port and starboard -- one for each throat (barrel), of each carburetor.

If the engine hesitates during acceleration after adjusting the idle mixture, the mixture is too lean. Enrich the mixture slightly, by turning the adjustment screw inward until the engine accelerates correctly.

Idle Speed

The idle speed is always adjusted **AFTER** the idle mixture has been set. Idle speed is considered the minimum rpm at which the powerhead will operate smoothly. The idle speed is set with an adjustable screw. This screw may be on the carburetor linkage, in the throttle linkage, or part of the ignition linkage, depending on the model being serviced.

Connect a flush device to the lower unit. **NEVER** operate the powerhead over 1000 rpm with a flush device attached, because the engine may **"RUNAWAY"** due to the no load condition on the propeller. A "runaway" engine could be severely damaged. Connect the fuel line to a fuel source. Plug the electrical harness into the engine receptacle. Remove the engine cowling. Connect a tachometer to the engine.



The idle speed adjustment (primary pickup), may be made with a flush attachment connected to the lower unit.

CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.

Start the powerhead and allow it to warm to operating temperature.

Remove the cable barrel from the barrel retainer, and loosen the locknut on the idle adjustment screw. Shift the engine into **FORWARD** gear. Adjust the idle rpm to the proper rpm as listed in the Specifications in the Appendix. Tighten the locknut to hold the adjustment. With the end of the throttle cable connected to the throttle lever, hold the throttle lever against the idle stop. Adjust the throttle cable barrel to slip into the barrel retainer on the cable anchor bracket with a very light preload of throttle lever against the idle stop. Lock the barrel in place.

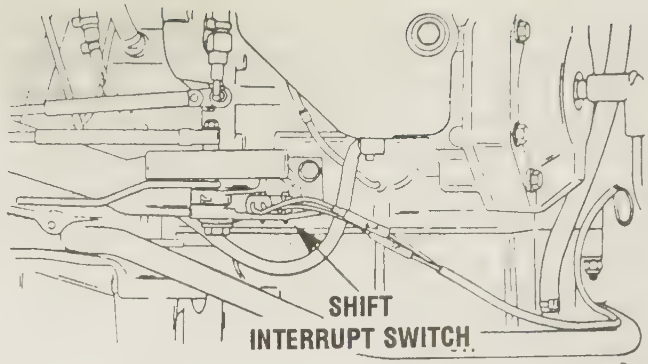
BAD NEWS

An excessive preload on the throttle cable will cause difficulty when shifting from **FORWARD** gear to **NEUTRAL**.

The preload may be easily checked by placing a piece of paper between the idle stop screw and the idle stop, and then withdrawing it. If the paper does not tear, but drag can still be felt, the preload is correct. Adjust the cable barrel, if necessary, to obtain the proper preload just described. Install the powerhead cowling.

Shift Interrupt Switch
Model 225hp Only

A shift interrupt switch is installed on the Model 225hp powerhead. This switch is activated by the shift lever and is designed to momentarily ground the ignition modules from the ignition cycle when shifting from **FORWARD** or **REVERSE** gear into **NEUTRAL**. The ignition modules for cylinders #2, #4 and #6 in the port bank **WILL BE** grounded when the interrupt switch is activated by the shift lever. The loss of three cylinders reduces the torque load on the sliding clutch in the lower unit, thus allowing the gear housing to be shifted into **NEUTRAL** with minimum effort. If considerable effort is required to shift the unit into neutral, see Chapter 5 to test the diode in the circuit.



*The shift interrupt switch **MOMENTARILY** grounds the ignition modules for No. 2, No. 4, and No. 6 cylinders when the outboard is shifted from either **FORWARD** or **REVERSE** into **NEUTRAL**.*

Disconnect the Black/Yellow wire lead bullet connector on the shift interrupt switch. Set the digital multimeter to Rx1 scale. Insert one meter test lead into the female connector of the shift interrupt switch. Insert the other meter test lead into pin #1 of the powerhead harness connector. Check the meter and observe the indication. Reverse the ohm meter test lead connections and again observe the meter indication. The system is functioning correctly if continuity is indicated in one direction and **NO** continuity is indicated in the opposite direction.

FINAL WORDS:

If sufficient throttle cable barrel adjustment is not available, a check **MUST** be made for correct installation of the link rod (located between the throttle lever and the throttle cam). Each end of this link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or the throttle cam casting, and then backed out from this position **ONLY** far enough to obtain correct orientation of the link rod. The link rod must be backed out **LESS** than one turn. All timing adjustments must be reset after this procedure has been completed. Disconnect the tachometer and the flush device.

6-2 ELECTRONIC IDLE STABILIZER AND SPARK ADVANCE MODULES

All V6 powerheads covered in this manual are equipped with one or more of the following units or combination of units:

an idle stabilizer
and/or
a high-speed advance module
and/or
a low speed/high speed spark advance module.

All of these units are "black boxes". By "black box" the term means the item is a sealed unit and cannot be opened or serviced. Therefore, if troubleshooting should indicate the module is defective, it **MUST** be replaced. In short, it either functions properly or it is replaced.

These "black box" units are usually installed on the upper front cowling support bracket, but may be found in other locations on various powerheads.

The **ONLY** method to determine which "black box" is installed on the powerhead being serviced is to make an identification of the wires from the "black box" to the switch boxes as follows:

Idle Stabilizer (2 or 3 mounting screws)	White/Black Red/White Black
High Speed Spark Advance Module (2 mounting screws)	Black White/Black Green/White Red/White
Low Speed/High Speed Spark Advance Module (3 mounting screws)	Red/White Black White/Black

"BLACK BOX" OPERATION

The following paragraphs give a brief explanation of the "black boxes" installed on the powerheads covered in this manual. The idle stabilizer is an optional unit and the speed limiter is installed only on the Model 275hp.

Idle Stabilizer

The idle stabilizer will electronically advance the timing by as much as 9°, if the idle speed falls below 550 rpm.

Low Speed/High Speed Spark Advance Module

The low speed/high speed spark advance module will affect both idle and high speed powerhead operation by advancing the spark at idle and high speed.

Speed Limiter Model 275hp Only

The speed limiter module is mounted low on the starboard side of the powerhead immediately below the main powerhead harness connector. Two Phillips head screws secure it to the powerhead. The module reduces ignition voltage to the port side cylinders -- #2, #4, and #6, when powerhead speed reaches between 6000 and 6200 rpm.

Idle Stabilizer Shift System

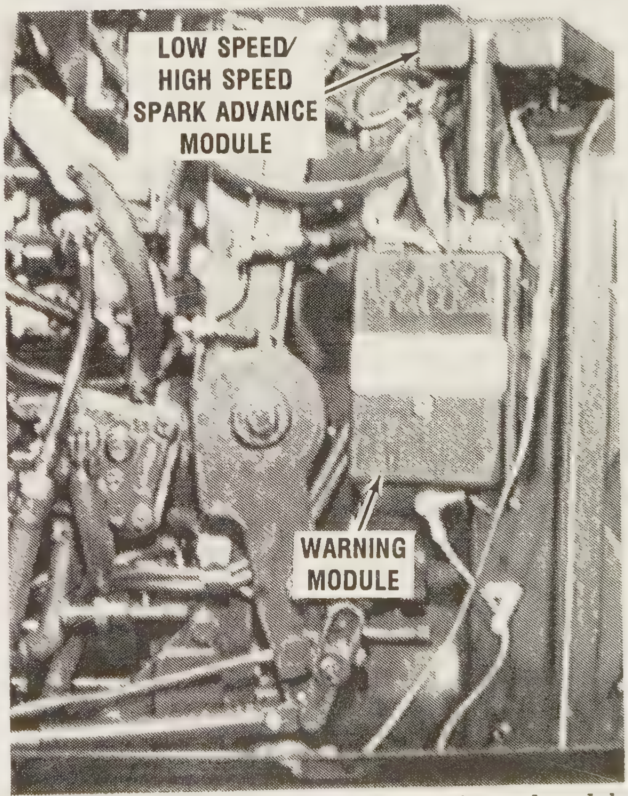
The idle stabilizer shift system is normally installed only on the 150XR6 and Magnum III models with a high pitch propeller installed.

The idle stabilizer shift system is designed to increase idle timing 3° when shifting from neutral into forward gear. This is to prevent the outboard from stalling after shifting into forward gear with a high pitch propeller installed.

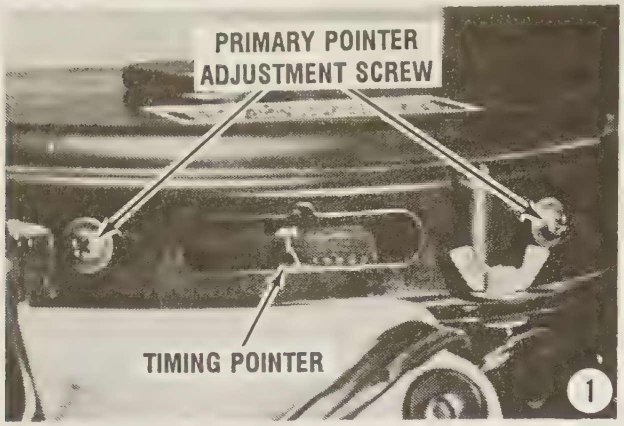
This system may be added to any V-6 powerhead as an accessory kit. When the idle stabilizer shift kit is installed, be sure to retard the maximum advance timing **MUST** be retarded 3° to offset the 3° advance at idle.

CRITICAL WORDS

When timing the powerhead using the cranking motor, the White/Black wire from the idle stabilizer or the low speed/high speed spark advance module **MUST BE DISCONNECTED** from the switch box and the end taped off with insulating tape. If this wire is not disconnected, there is no way on this green earth to properly time the powerhead.



Typical location of the low speed/high speed module and the idle stabilizer module.



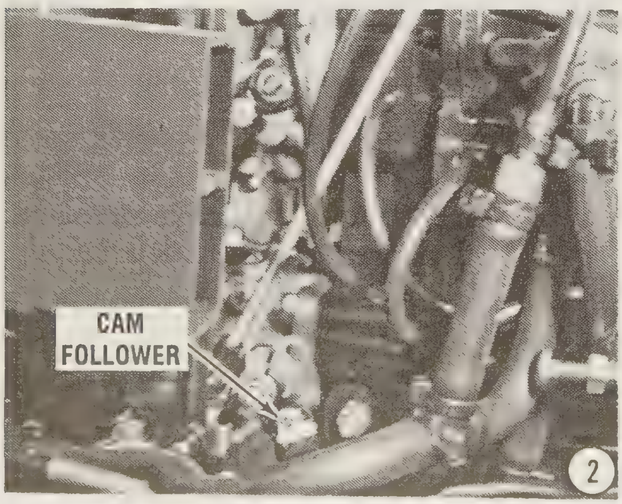
6-3 MODELS 135, 150HP, 150XR4, MAGNUM II, 150XR6, MAGNUM III, 175, AND 200HP -- CARBURETED WITH IDLE STABILIZATION OR LOW SPEED / HIGH SPEED SPARK ADVANCE MODULE

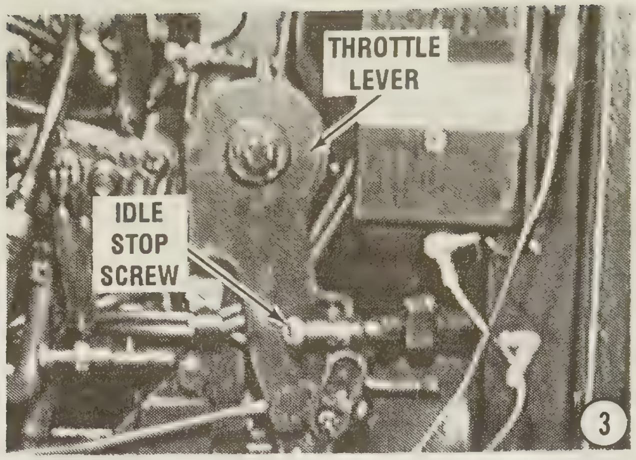
Timer Pointer Adjustment

1- Remove all spark plugs. Install a dial indicator into the No.1 (top cylinder starboard bank), spark plug opening. Slowly rotate the flywheel **CLOCKWISE** until the No. 1 piston is at top dead center (TDC). Set the dial indicator to "0". Slowly rotate the flywheel **COUNTER-CLOCKWISE** until the dial indicator needle is 1/4 turn beyond the .462" mark.

On some models with a one piece flywheel, a 4/5 (45^0) mark on the flywheel is equal to the .462 mark on flexplate type flywheels.

Now, slowly rotate the flywheel back **CLOCKWISE** until the dial indicator is **EXACTLY** at the .462". Observe the timing pointer on the flywheel cover and the .462" mark on the flywheel. If the flywheel pointer is not exactly on the mark, loosen the pointer adjustment screws and align the pointer with the .462"



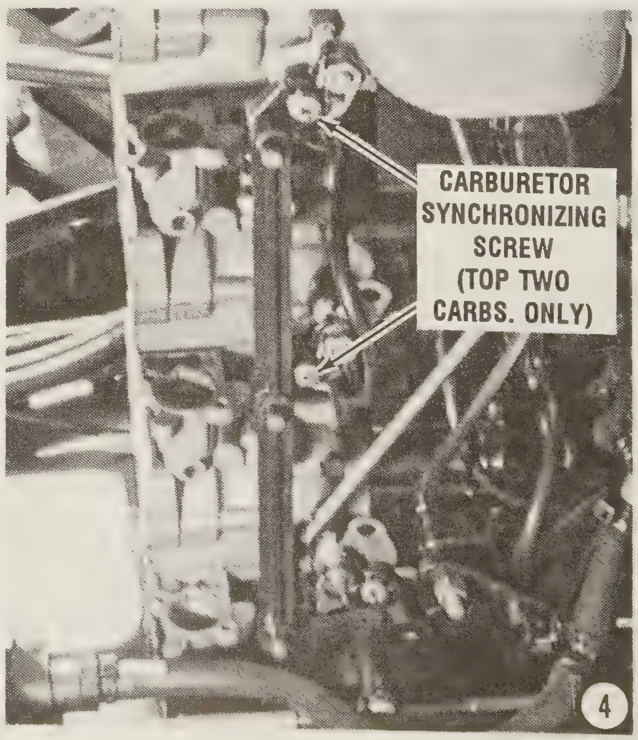


mark. Tighten the pointer adjustment screws. Remove the dial indicator from the No. 1 spark plug opening.

Throttle Cam Adjustment

2- Check to be **SURE** the remote control throttle lever is in neutral and idle position. On the powerhead -- loosen the cam follower screw to allow the cam to move freely.

3- Hold the throttle lever against the idle stop and check the alignment mark on throttle cam. The alignment mark **MUST** be centered with the cam roller. If the mark is not aligned, loosen the locknut on the idle stop screw and adjust the idle stop screw until the mark on the cam is centered in the cam roller. Tighten the locknut on the idle stop screw to hold the adjustment. **DO NOT** tighten the cam follower screw at this time.



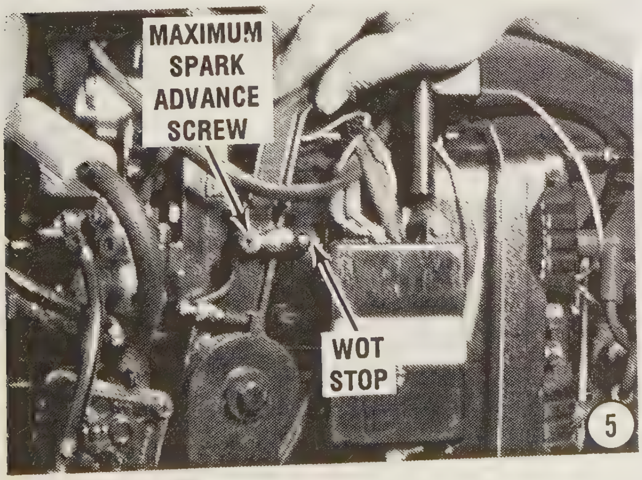
Carburetor Synchronization

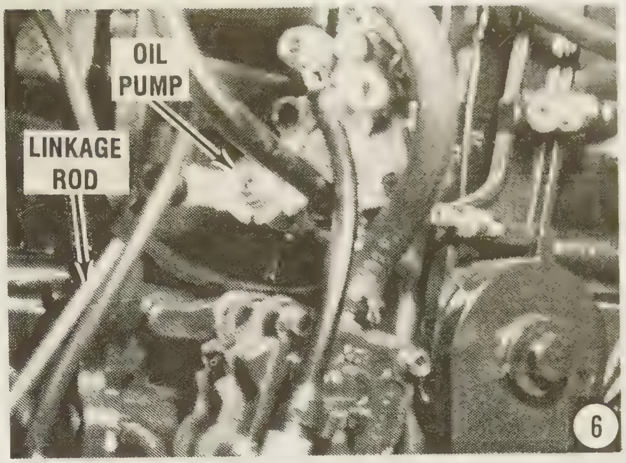
4- Remove the air box cover from the powerhead. Loosen the two carburetor synchronization screws on the two upper carburetor linkage arms. Check to be sure the shutter plates in the carburetors are completely closed. Move the throttle lever to allow the idle stop screw to make contact against the idle stop. Hold the throttle lever in this position. Move the cam follower roller next to the throttle cam until the roller is just barely making contact with the throttle cam. **CAREFULLY**, tighten the carburetor synchronization screws, and the cam follower roller screw without disturbing any of the adjustments. Move the throttle lever and check to be sure the shutter plates on all three carburetors open and close simultaneously. Repeat this step if any shutter plate lags.

5- Move the throttle lever to the wide open throttle (WOT), position. Loosen the locknut and adjust the full throttle stop screw until the carburetor shutters are fully open at WOT. Check to be sure the throttle shutters **DO NOT** act as throttle stops. Use a feeler gauge and check for 0.010 - 0.015" (.25mm - .38mm), clearance between the cam follower roller and the throttle cam. Tighten the locknut on the full throttle stop screw to hold this adjustment.

Carburetor Oil Pump Synchronization

6- Move the powerhead throttle lever so the idle stop screw is against the idle stop. Check the alignment mark on the oil pump lever. The mark should be aligned with the casting mark on the oil pump body. If the mark is not aligned, disconnect the linkage rod from the oil pump lever. Screw the rod end -- in or out -- to align the mark on the oil pump body with the





mark on the lever. Connect the rod end onto the oil pump lever.

Trigger Link Rod Measurement

7- If the link rod was disassembled, measure the length of the trigger link rod from the center line of the 90° bend to the edge of the locknut. The dimension must be 11/16" (17.5mm) for proper timing adjustment.

Maximum Timing Adjustment

SAFETY PROCEDURE

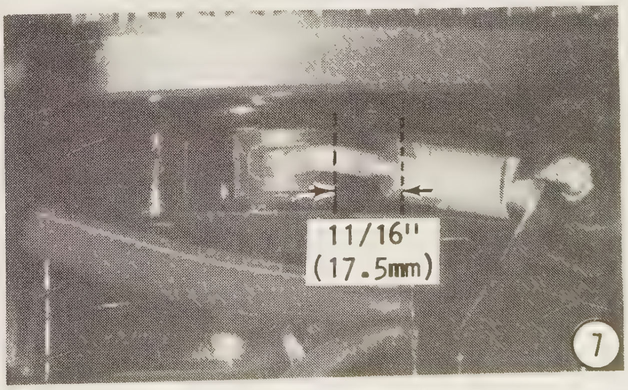
To prevent the powerhead from firing during the timing procedures and/or possibly damaging components, perform the following steps.

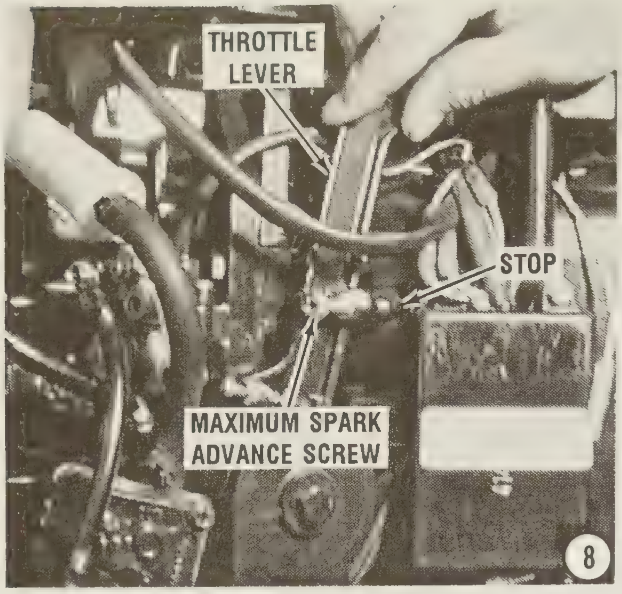
a- Install a grounding clip into each of the spark plug wire boots and connect the other end of the clip to a good powerhead ground.

b- Disconnect the fuel line from the fuel source.

c- Remove the throttle cable barrel from the barrel retainer on the cable anchor bracket.

d- Disconnect and wrap tape around the end of the White/Black lead from the idle stabilizer module (starboard side of the powerhead), at the bullet connector.





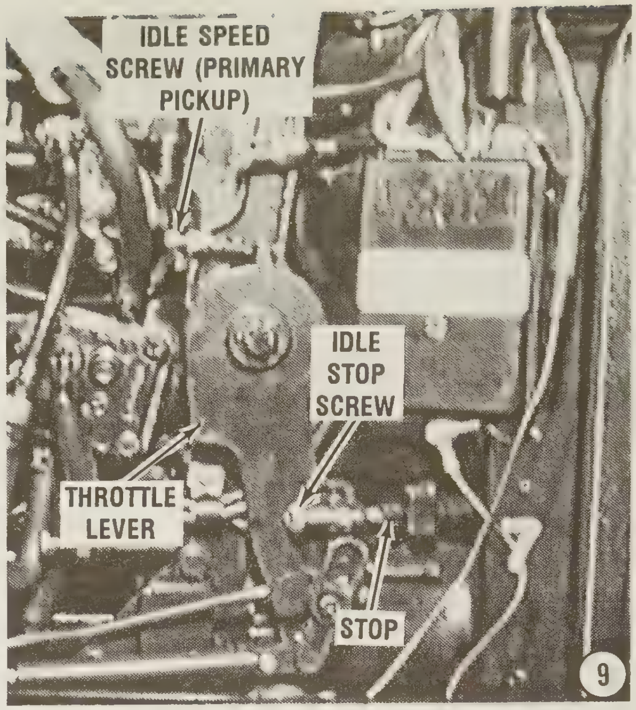
CRITICAL WORDS

All models, except XR4, XR6, Magnum II, Magnum III and 175hp equipped with the Idle Stabilizer Shift Kit, require the maximum spark advance timing be retarded 3^0 from the timing Specifications listed in the Appendix. The Idle Stabilizer Shift Kit is standard equipment on the above listed models. Therefore, the timing in the specifications has been adjusted for these models.

8- Connect a timing light to the No. 1 spark plug high tension lead. Check to be sure the lower unit is in **NEUTRAL**. Move the throttle lever until the maximum spark advance screw is against the stop. Have an assistant crank the powerhead with the cranking motor and at the same time hold the timing light pointed at the timing decal on the flywheel. Loosen the locknut and adjust the maximum spark advance timing to the Specifications in the Appendix. Re-tighten the locknut on the maximum spark advance screw to hold the adjustment.

AN EXPLANATION

The timing specifications while using the cranking motor are slightly off from the specifications at operating rpm. This is due to the advance and retard characteristics of the ignition system. Therefore, all timing adjustments made using the cranking motor method should be verified with the outboard running at the recommended speeds. If necessary, make adjustment -- as needed -- to bring the timing within the specification listed in the Appendix.



Primary Pick-Up Timing Adjustment

9- With the outboard in **NEUTRAL,** hold the throttle lever against the idle stop screw. Have an assistant crank the powerhead with the cranking motor and at the same time hold the timing light pointed at the timing decal on the flywheel. Loosen the locknut and adjust the throttle primary pick-up screw to the Specifications in the Appendix. Tighten the locknut on the throttle primary pick-up screw to hold the adjustment.

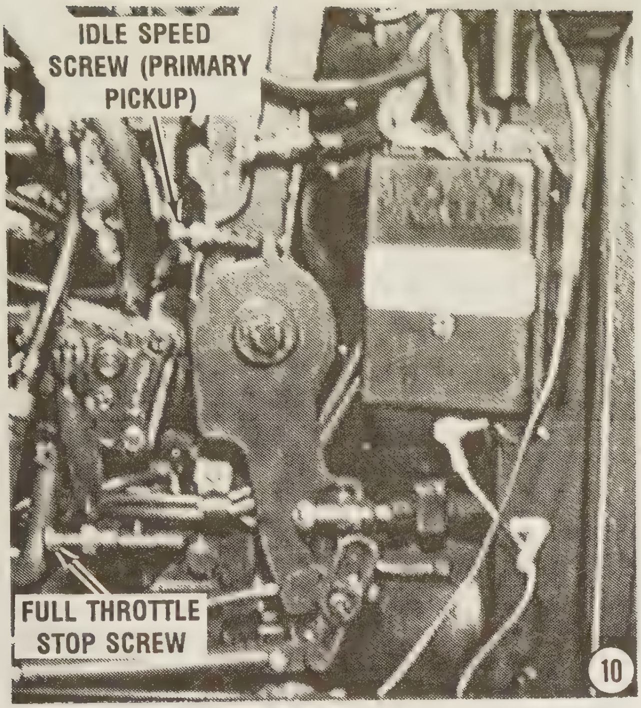
The primary pick-up timing will also determine powerhead speed at idle. Refer to the following Idle Speed Adjustment procedures.

Idle Speed Adjustment

CRITICAL WORDS

The following procedures **MUST** be performed with the outboard in a test tank or the boat and outboard in a body of water. The idle speed adjustment procedures can only be preformed with the outboard running with the lower unit in **FORWARD** gear and the propeller under an actual load condition.

DO NOT connect a flush device to the lower unit for this adjustment, because the outboard unit **MUST** be under load with the lower unit in **FORWARD** gear.



CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Perform the following steps to prepare the outboard for operation.

a- Remove the timing light from the powerhead No. 1 spark plug lead.

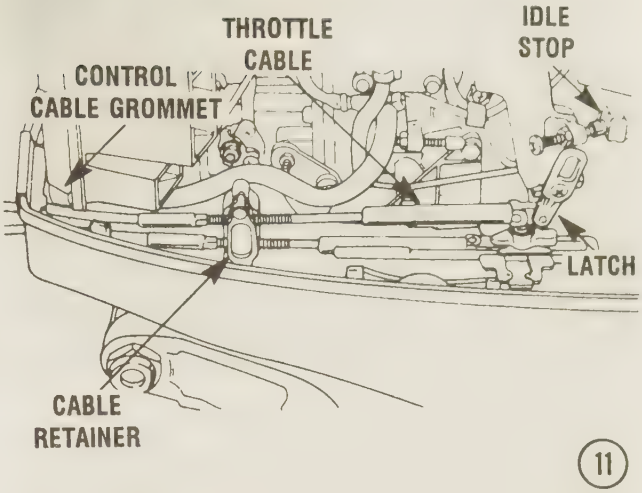
b- Remove all the ground leads from the spark plug wire boots. Install the spark plugs and tighten them to a torque value of 17 ft lb (23.0 Nm). Connect the spark plug leads to the spark plugs .

c- Connect the idle stabilizer White/Black lead (starboard side of the powerhead), to the bullet connector.

d- Connect a tachometer to the powerhead at the rectifier Gray wire terminal or one of the Yellow wire terminals on the terminal block.

e- Connect the fuel line to the fuel tank and prime the fuel system.

10- Start the powerhead and allow it to warm to operating temperature. Loosen the locknut on the primary pick-up screw. Place the outboard into **FORWARD** gear and monitor the powerhead rpm. Adjust the primary pickup screw until the powerhead rpm is as listed in the Specifications in the Appendix. The powerhead idle rpm **MUST NEVER** exceed 750



rpm in gear. Tighten the locknut on the primary pickup screw to hold the adjustment.

If the outboard is not to be used in the very near future, place the throttle in neutral and disconnect the fuel line. Allow the powerhead to operate until all fuel is used in the carburetors. Set the key switch to **OFF**. Disconnect the tachometer leads (if used), from the rectifier or terminal block.

Throttle Cable Preload Adjustment

11- With the end of the throttle cable connected to the throttle lever anchor pin, hold the throttle lever against the idle stop. Adjust the throttle cable barrel until it will slip into the barrel retainer on the cable anchor bracket. If necessary, adjust the throttle cable barrel until there is a very light preload on the throttle lever against the idle stop. Lock the barrel in place.

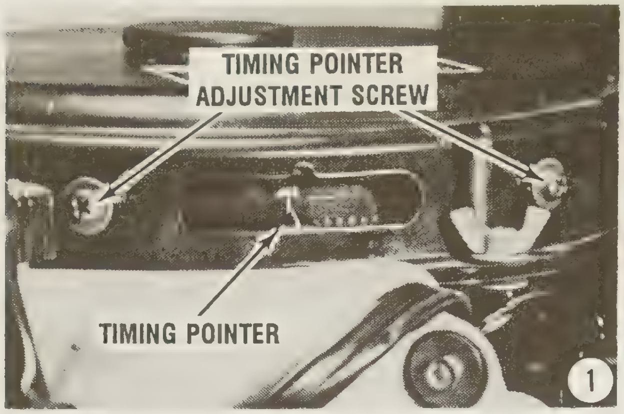
BAD NEWS

An excessive preload on the throttle cable will cause difficulty when shifting from **FORWARD** gear to **NEUTRAL**.

The preload may be easily checked by placing a piece of paper between the idle stop screw and the idle stop, and then withdrawing it. If the paper does not tear, but drag can be felt, the preload is correct. Adjust the cable barrel, if necessary, to obtain the proper preload just described. Install the powerhead cowling.

FINAL WORDS

If sufficient throttle cable barrel adjustment is not available, a check **MUST** be made for correct installation of the link rod (located



between the throttle lever and the throttle cam). Each end of the link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or the throttle cam casting, and then backed out from this position **ONLY** far enough to obtain correct orientation of the link rod. The link rod must be backed out **LESS** than one full turn. All timing adjustments **MUST** be reset after this procedure has been completed. Disconnect the tachometer and install the powerhead cowling.

6-4 MODEL 225HP WITH MODULAR CDI COMPUTER CONTROLS

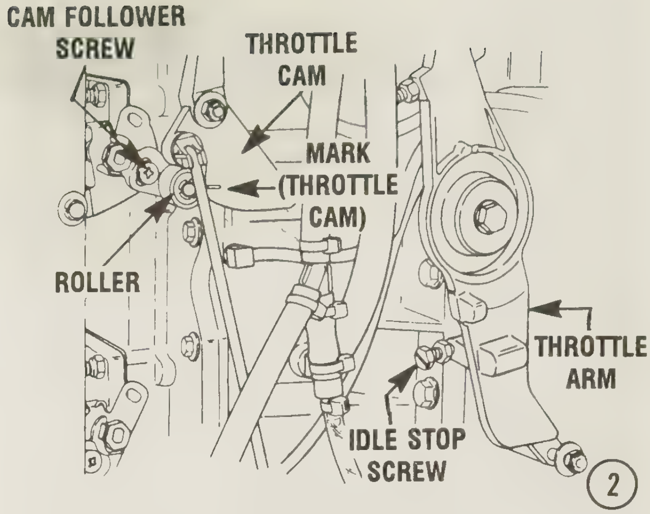
Timer Pointer Adjustment

1- Remove all spark plugs. Install a dial indicator into the No.1 (top cylinder starboard bank), spark plug opening. Slowly rotate the flywheel **CLOCKWISE** until the No. 1 piston is at top dead center (TDC). Set the dial indicator to "**0**". Slowly rotate the flywheel **COUNTER-CLOCKWISE** until the dial indicator needle is 1/4 turn beyond the .526" mark.

Now, slowly rotate the flywheel back **CLOCKWISE** until the dial indicator is **EXACTLY** at the .526" (11.7mm), mark. Observe the timing pointer on the powerhead and the .526" mark on the flywheel. If the timing pointer is not exactly on the mark, loosen the pointer adjustment bolt and align the pointer with the .526" mark on the flywheel. Tighten the pointer adjustment bolt to a torque value of 105 in lb (11.8Nm). Remove the dial indicator from the No. 1 spark plug opening.

Throttle Cam Adjustment

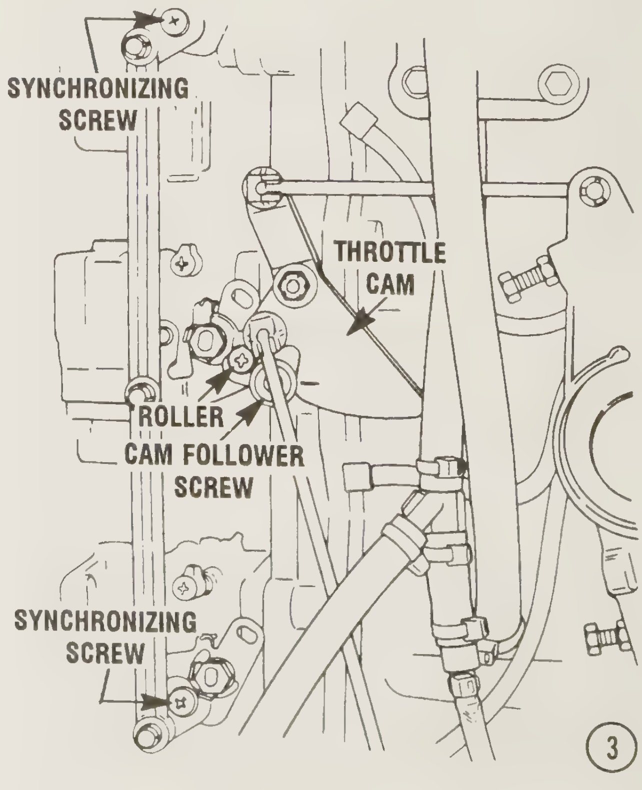
2- Check to be **SURE** the remote control throttle lever is in the **NEUTRAL** and idle position. On the powerhead, loosen the cam follow-

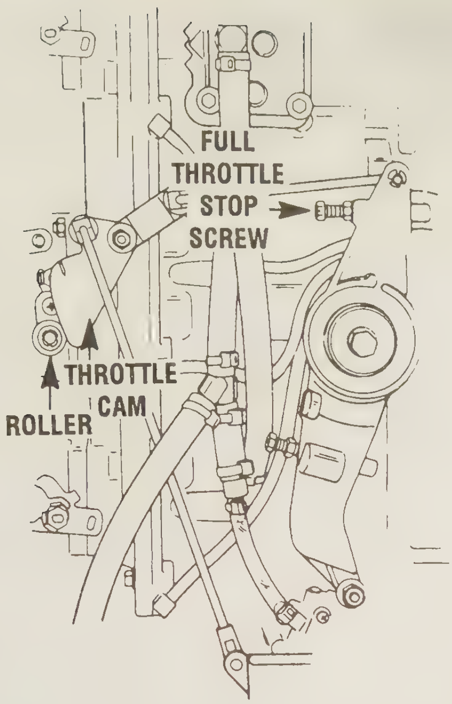


er screw to allow the cam to move freely. Hold the throttle lever against the idle stop and check the alignment mark on throttle cam. The mark should be centered with the cam roller. If the mark is not aligned, loosen the locknut on the idle stop screw and adjust the idle stop screw until the mark on the cam is centered in the cam roller. Tighten the locknut on the idle stop screw to hold the adjustment. **DO NOT** tighten the cam follower screw at this time.

Carburetor Synchronization

3- Loosen the two carburetor synchronization screws on the two upper carburetor linkage arms. Check to be sure the shutter plates in the carburetors are completely closed. Hold the





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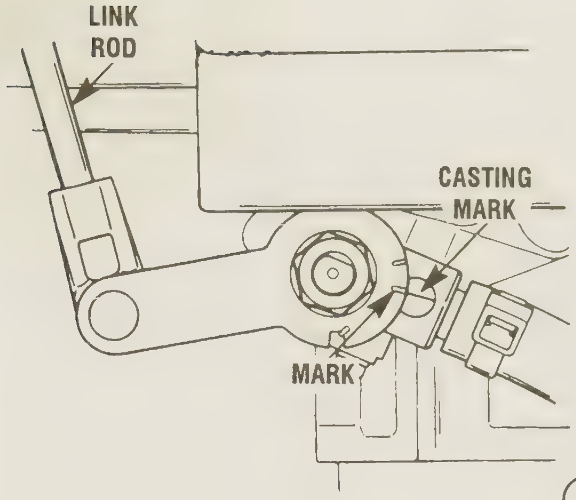
throttle lever with the idle stop screws against the idle stop. Move the cam follower roller next to the throttle cam until the roller barely makes contact with the throttle cam. **CAREFULLY**, tighten the carburetor synchronization screws, and the cam follower roller screw without disturbing any of the adjustments. Move the throttle lever from idle to half throttle while checking the shutter plates on all three carburetors. The shutters should open and close simultaneously. Repeat this step if any shutter plate lags.

4- Move the throttle lever to the wide open throttle (WOT) position. Loosen the locknut and adjust the full throttle stop screw until the carburetor shutters are fully open at WOT. Check to be sure the throttle shutters **DO NOT** act as throttle stops. Use a feeler gauge and check for .010 - .015" (.25mm - .38mm) clearance between the cam follower roller and the throttle cam. Tighten the locknut on the full throttle stop screw to hold this adjustment.

Carburetor Oil Pump Synchronization

5- Move the powerhead throttle lever so the idle stop screw is against the idle stop. Check the alignment mark on the oil pump lever. The mark should be aligned with the casting mark on the oil pump body. If not, disconnect the linkage rod from the oil pump lever. Screw the rod end, in or out, to align the mark on the oil pump body with the mark on the lever. Connect the rod end onto the oil pump lever.



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Throttle Position Indicator (TPI) Idle Speed Adjustments

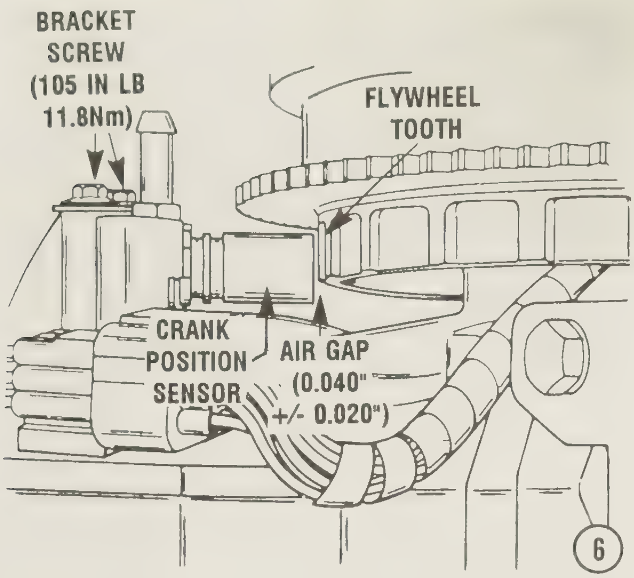
GOOD WORDS

The throttle position sensor (TPI) is used for low speed and mid-range power settings. The TPI transmits throttle position information to the ECU controller in the form of a low voltage signal. This low voltage signal will range from .950 VDC at the idle position to 3.91VDC at WOT setting. A lower voltage setting will cause the powerhead timing to retard and a higher voltage will advance the timing. A 0.050 volt change in the TPI setting, results in a 1^{0} change in the powerhead timing.

Alignment and adjustment of the TPI is a critical step in the timing and synchronizing of the powerhead. This procedure requires the use of a digital multimeter and special in-line harness connector to monitor the TPI voltage output during throttle operation. This equipment is expensive and the procedure should **ONLY** be performed by a qualified Mercury/Mariner technician.

Crankshaft Position Sensor Adjustment

6- Remove the flywheel cover, if it is still in place. Rotate the flywheel **CLOCKWISE** by hand and align one of the flywheel sensor teeth directly in line (perpendicular), with the crankshaft position sensor. Using a feeler gauge, measure the gap between the sensor and flywheel tooth. The allowable gap measurement is 0.040" ± 0.020" (1.02mm ± 0.51mm). If the gap is incorrect, loosen the two sensor bracket bolts. Set the gap to the correct measurement and tighten the two sensor bracket bolts to a



torque value of 105 in lb (11.8Nm). Install the flywheel cover.

Maximum Timing

Maximum spark timing is controlled by the electronic control unit (ECU) and is not adjustable. As long as the electronic control unit, crankcase position and throttle position sensor are functioning properly, the maximum timing will be correct.

Idle Speed Adjustment

CRITICAL WORDS

The following procedures **MUST** be performed with the outboard in a test tank or the boat and outboard in a body of water. The idle speed adjustment procedures can only be preformed with the outboard running with the lower unit in **FORWARD** gear and the propeller under an actual load condition.

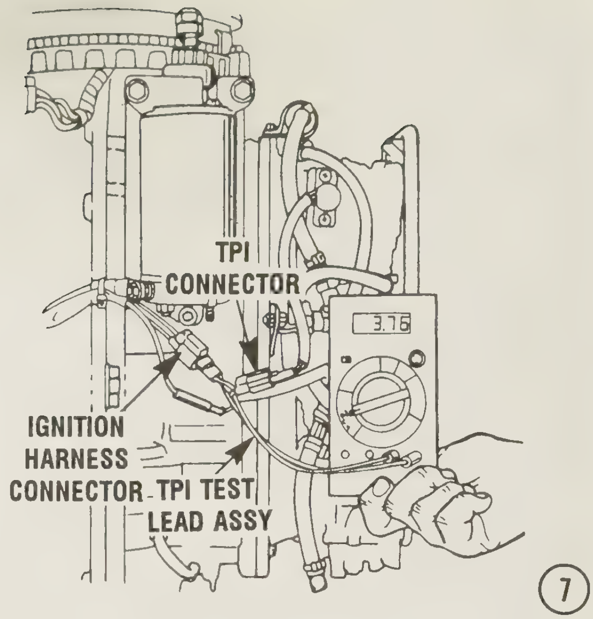
DO NOT connect a flush device to the lower unit for this adjustment, because the outboard unit **MUST** be under load with the lower unit in **FORWARD** gear.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Perform the following steps to prepare the outboard for operation.

a- Remove the timing light from the powerhead No. 1 spark plug lead.



b- Remove all the ground leads from the spark plug boots. Install the spark plugs and tighten them to a torque value of 17 ft lb (23.0 Nm). Connect the spark plug leads to the spark plugs.

c- Connect a tachometer to the powerhead at the rectifier Gray wire terminal or one of the Yellow wire terminals on the terminal block.

d- Connect the fuel line from the fuel tank to the powerhead and prime the fuel system.

7- Start the powerhead and allow it to warm to operating temperature. Place the outboard into **FORWARD** gear and monitor the powerhead rpm. The rpm should be close to the listing in the Specifications in the Appendix. The powerhead idle rpm **MUST NEVER** exceed 650 rpm in gear. If the powerhead rpm is not correct, verify carburetor synchronization and/or carburetor mixture settings. If synchronization and fuel mixture are correct, the idle speed may be adjusted by repositioning the TPI sensor. See TPI Adjustment of Idle Timing in this section.

Place the throttle in **NEUTRAL** and disconnect the fuel line to the outboard unit. If the outboard is not to be used for some tine, allow the outboard to operate until all fuel is used in the carburetors. Set the key switch to **OFF**. Disconnect the tachometer leads (if used) from the rectifier or terminal block.

Throttle Cable
Preload Adjustment

With the end of the throttle cable connected to the throttle lever anchor pin hold the throttle

lever against the idle stop. Adjust the throttle cable barrel until it will slip into the barrel retainer on the cable anchor bracket. If necessary, adjust the throttle cable barrel until there is a very light preload on the throttle lever against the idle stop.

BAD NEWS

An excessive preload on the throttle cable will cause difficulty when shifting from **FORWARD** gear into **NEUTRAL**.

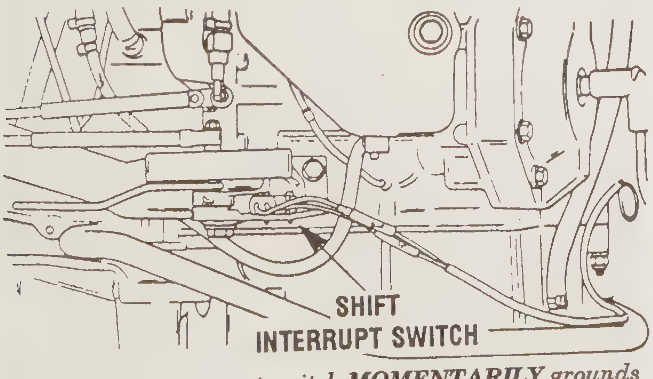
The preload may be easily checked by placing a piece of paper between the idle stop screw and the idle stop, and then withdrawing it. If the paper does not tear, but drag can be felt, the preload is correct. Adjust the cable barrel, if necessary, to obtain the proper preload just described. Install the powerhead cowling.

Shift Interrupt Switch
Model 225hp Only

A shift interrupt switch is installed on the Model 225hp powerhead. This switch is activated by the shift lever and is designed to momentarily ground the ignition modules from the ignition cycle when shifting from **FORWARD** or **REVERSE** gear into **NEUTRAL**. The ignition modules for cylinders #2, #4 and #6 in the port bank **WILL BE** grounded when the interrupt switch is activated by the shift lever. The loss of three cylinders reduces the torque load on the sliding clutch in the lower unit, thus allowing the gear housing to be shifted into **NEUTRAL** with minimum effort. If considerable effort is required to shift the unit into neutral, see Chapter 5 to test the diode in the circuit.

FINAL WORDS

If sufficient throttle cable barrel adjustment is not available, a check **MUST** be made for correct installation of the link rod (located between the throttle lever and the throttle cam). Each end of the link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or the throttle cam casting, and then backed out from this position **ONLY** far enough to obtain correct orientation of the link rod. The link rod must be backed out **LESS** than one full turn. All timing adjustments **MUST** be reset after this procedure has been completed. Disconnect the tachometer and install the powerhead cowling.



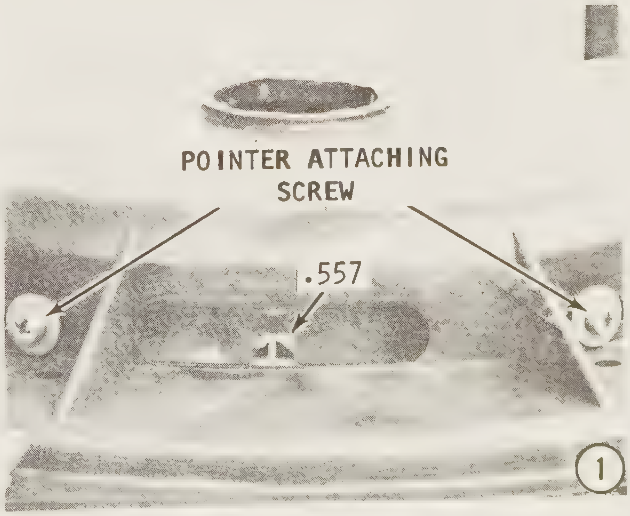
The shift interrupt switch ***MOMENTARILY*** *grounds the ignition modules for No. 2, No. 4, and No. 6 cylinders when the outboard is shifted from either* ***FORWARD*** *or* ***REVERSE*** *into* ***NEUTRAL.***

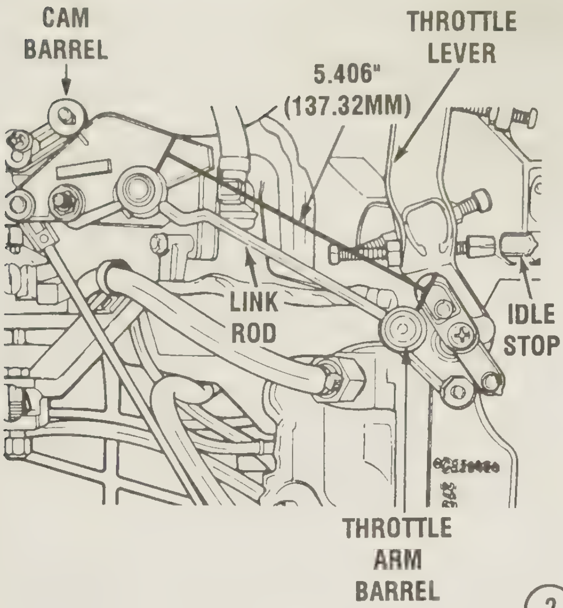
6-5 MODEL 275HP WITH SIX CARBURETORS

Timer Pointer Adjustment

1- Remove all spark plugs. Install a dial indicator into the No.1 (top cylinder starboard bank), spark plug opening. Slowly rotate the flywheel **CLOCKWISE** until the No. 1 piston is at top dead center (TDC). Set the dial indicator to "**0**". Slowly rotate the flywheel **COUNTERCLOCKWISE** until the dial indicator needle is 1/4 turn beyond the .557" mark.

Now, slowly rotate the flywheel back **CLOCKWISE** until the dial indicator is **EXACTLY** at the .557" mark. Observe the timing pointer on the powerhead and the .557" mark on the flywheel. If the timing pointer is not exactly on the mark, loosen the pointer adjustment bolt and align the pointer with the .557" mark on the flywheel. Tighten the pointer adjustment bolt to a torque value of 105 in lb (11.8Nm). Remove the dial indicator from the No. 1 spark plug opening. Install and tighten the spark plugs.





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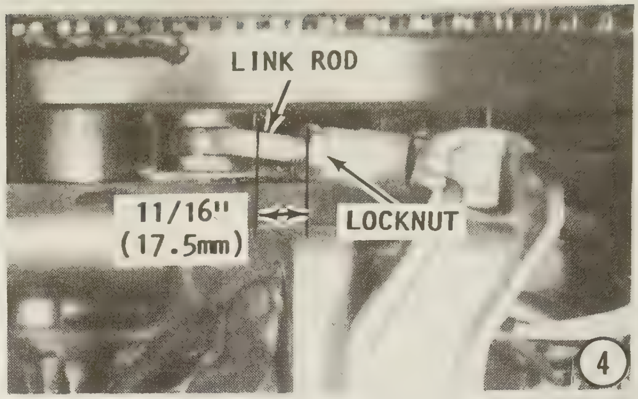

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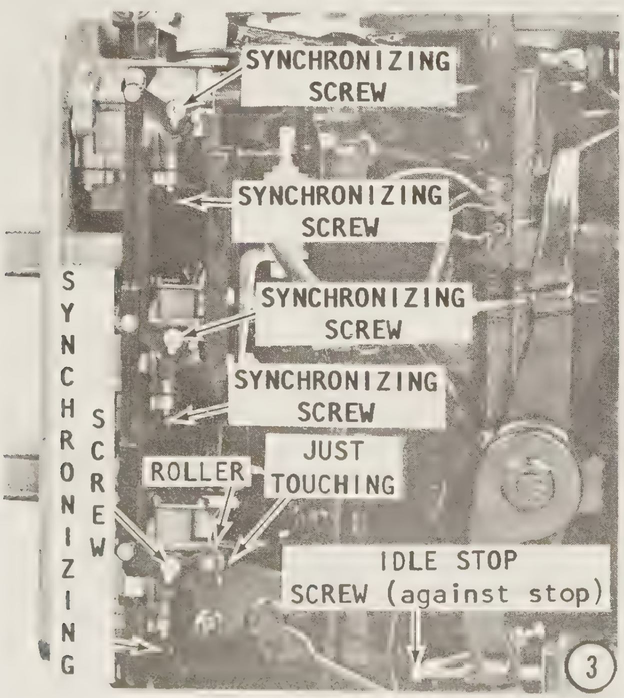
Carburetor Synchronizing

2- Position the throttle lever idle stop screw against the idle stop. Measure the distance between the throttle arm barrel and the cam barrel. The measurement from center to center should be 5.406" inches (137.32mm). If necessary, adjust the link rod for the correct measurement.

3- Remove the screws securing the sound box cover to the powerhead. Loosen the six carburetor synchronizing screws. Position the throttle lever against the idle stop. Position the throttle roller to just make contact with the throttle cam. Adjust the idle stop screw to align the slash mark on the throttle cam with the center of the throttle roller. Tighten the idle stop screw locknut. Hold the throttle roller arm steady and tighten the six carburetor screws to hold the adjustment.

Move the throttle lever from idle to half throttle while looking at the carburetor shutters. Be sure **ALL** carburetor shutters open and close simultaneously. Repeat this step if any carburetor shutter does not fully close or move at the same time. Install the sound box cover and secure with screws.

4- If the link rod was disassembled, check to be sure 11/16" (17.5mm) dimension is held, as shown in the accompanying illustration.



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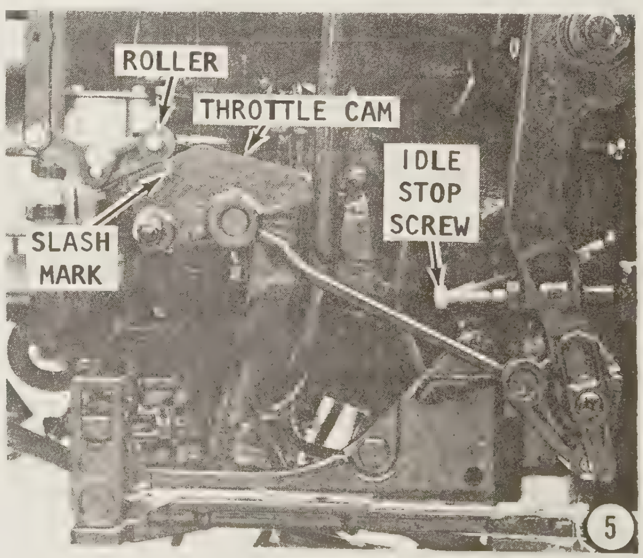
SAFETY WORDS

To prevent the powerhead from firing during the timing procedure, remove all spark plugs **EXCEPT** the No. 1 plug (top, starboard bank).

5- Connect the timing light to the No. 1 spark plug. Remove the throttle cable barrel



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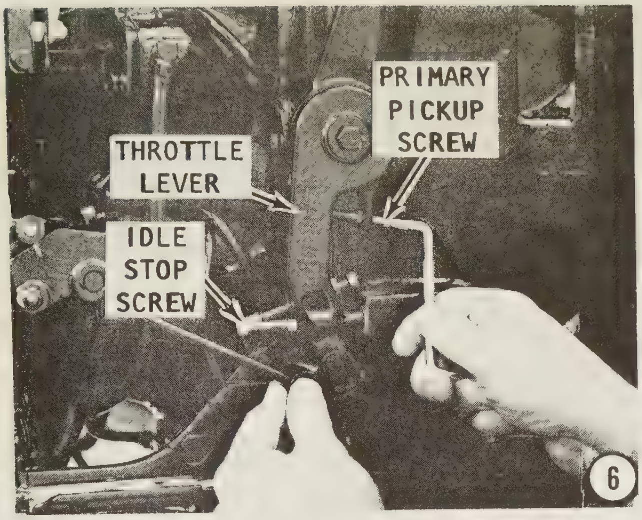
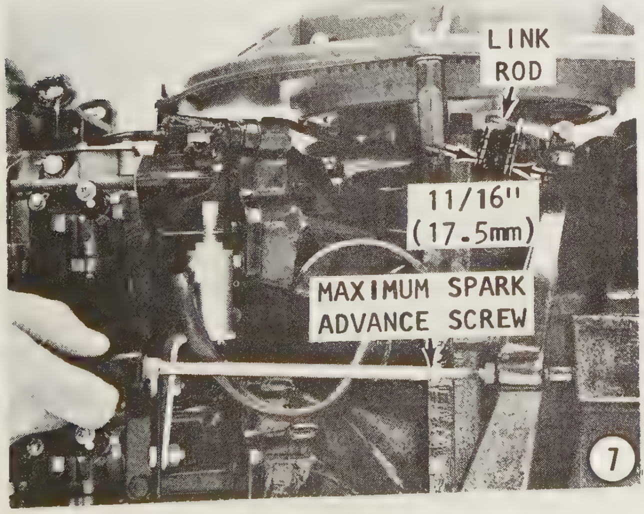
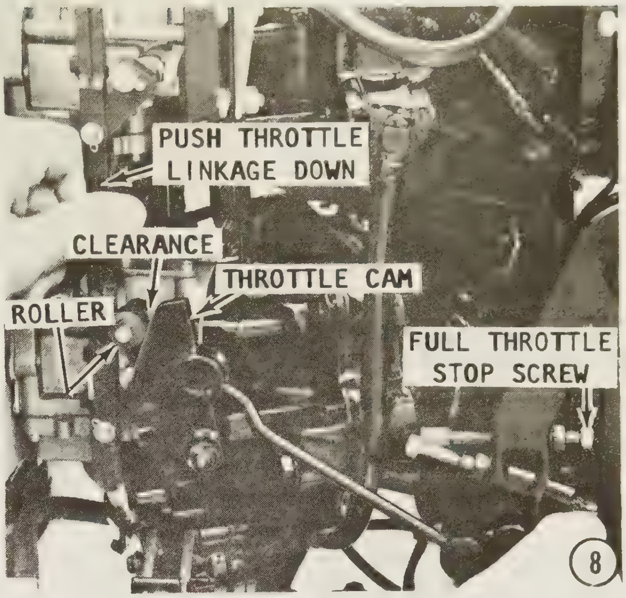


from the barrel retainer on the cable anchor bracket. Loosen the locknut on the idle stop screw. Adjust the idle stop screw until the slash mark on the throttle cam is at the point of contact with the roller. Tighten the locknut on the idle stop screw to hold this adjustment. Do **NOT** install the throttle cable at this time.

Primary Pickup Timing Adjustment

6- Check to be sure the outboard is in **NEUTRAL.** Hold the throttle arm with the idle stop screw against the idle stop and at the same time crank the powerhead with the cranking motor. While the powerhead is being cranked, adjust the throttle primary pickup screw until the specified throttle primary pickup mark on the timing decal is aligned with the timing pointer. See the Specifications in the Appendix for the correct setting. Tighten the locknut to hold the adjustment.





Maximum Advance Timing

7- Check to be sure the outboard is in **NEUTRAL.** Move the throttle lever until the maximum spark screw makes contact with the stop. Have an assistant crank the powerhead with the cranking motor. Loosen the locknut and adjust the maximum spark screw until the 22° mark on the flywheel is aligned with the timing pointer.

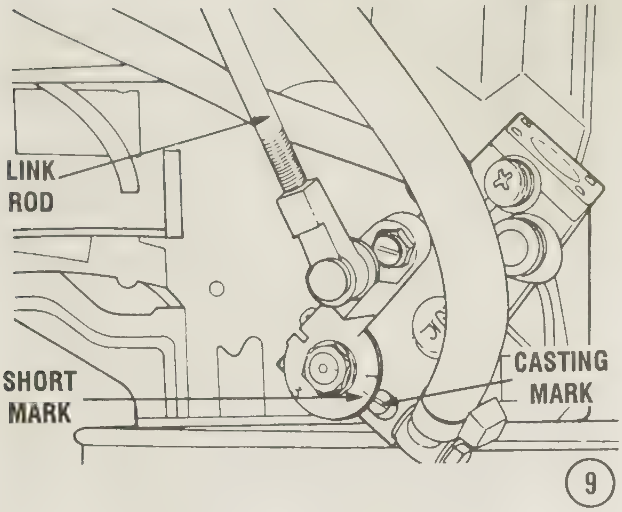
AN EXPLANATION

This adjustment will result in a spark advance of 20° at maximum rpm, due to the spark advance characteristics of this particular ignition system.

Tighten the locknut to hold the adjustment. Remove the timing light.

Throttle Stop Adjustment

8- Move the throttle lever to the wide open throttle (WOT) position. Loosen the locknut and adjust the full throttle stop screw to permit full throttle shutter opening at WOT. Check to be sure the throttle shutter does not act as a throttle stop. Use a feeler gauge and check the clearance between the roller and the throttle cam at WOT. This clearance should be 0.010-0.015" (0.25-0.38mm). Tighten the locknut to hold the adjustment. Install and tighten the spark plugs.



Carburetor/Oil Pump Synchronization

9- Move the powerhead throttle lever until the idle stop screw makes contact with the idle stop. Check the alignment mark on the oil pump lever (first shortest mark), is aligned with the casting mark on the oil pump body. If not, disconnect the linkage rod from the oil pump lever. Screw the rod end, in or out, to align the mark on the oil pump body with the mark on the lever. Connect the rod end onto the oil pump lever.

Idle Adjustment

In order to make proper idle adjustment, the boat **MUST** be backed into a test tank or secured in a body of water with the unit in **FORWARD** gear, thus placing a load on the propeller. Connect the fuel line to a fuel source. Plug the electrical harness into the powerhead receptacle. Remove the powerhead cowling. Connect a tachometer to the powerhead.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Start the powerhead and allow it to warm to operating temperature.

Remove the cable barrel from the barrel retainer, and loosen the locknut on the idle adjustment screw. Shift the outboard into **FORWARD** gear.

Adjust the idle rpm to the proper rpm, as listed in the Specifications in the Appendix. Tighten the locknut to hold the adjustment. With the end of the throttle cable connected to the throttle lever, hold the throttle lever against the idle stop. Adjust the throttle cable barrel to slip into the barrel retainer on the cable anchor bracket with a very light preload of throttle lever against the idle stop. Lock the barrel in place.

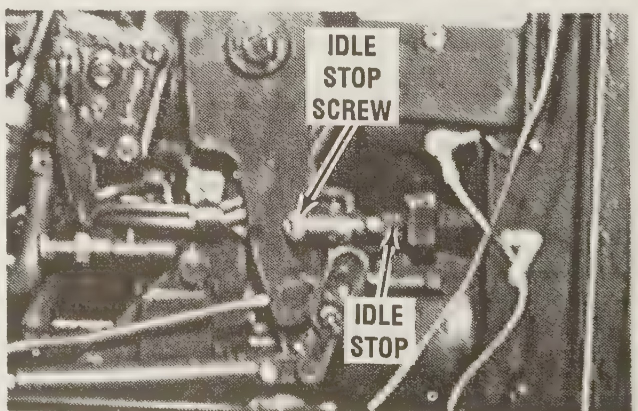
BAD NEWS

An excessive preload on the throttle cable will cause difficulty when shifting from **FORWARD** gear to **NEUTRAL**.

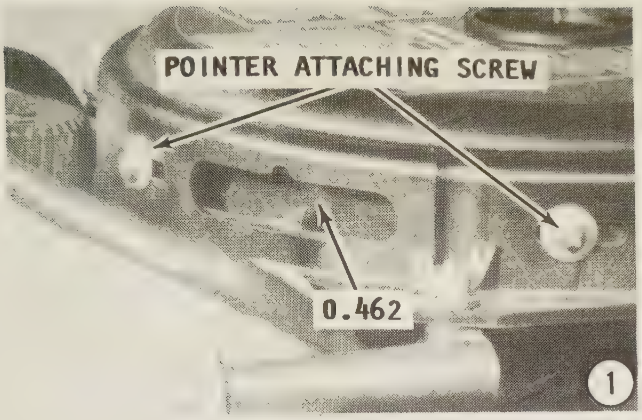
The preload may be easily checked by placing a piece of paper between the idle stop screw and the idle stop, and then withdrawing it. If the paper does not tear, but drag is felt, the preload is correct Adjust the cable barrel, if necessary, to obtain the proper preload just described. Install the powerhead cowling.

FINAL WORDS

If sufficient throttle cable barrel adjustment is not available, a check **MUST** be made for correct installation of the link rod (located between the throttle lever and the throttle cam). Each end of this link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or the throttle cam casting, and then backed out from this position **ONLY** far enough to obtain correct orientation of the link rod. The link rod must be backed out **LESS** than one turn. All timing adjustments must be reset after this procedure has been completed. Disconnect the tachometer and the flush device.



If a piece of paper is inserted between the idle stop screw and the stop -- before the adjustment is made and then the paper withdrawn with just a bit of "drag" after the adjustment -- the preload adjustment is correct.



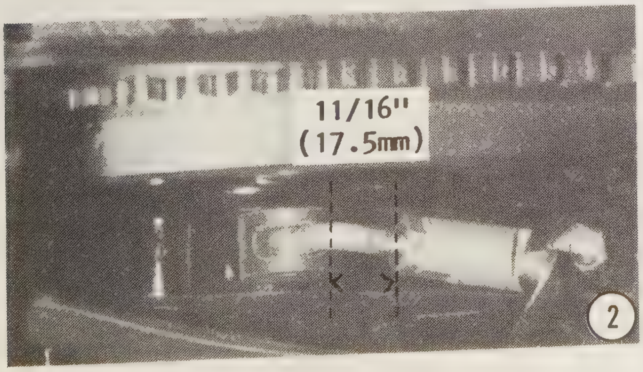
6-6 MODELS 150XRi, 175 Ski, 175XRi, AND 200XRi WITH ELECTRONIC FUEL INJECTION -- EFI

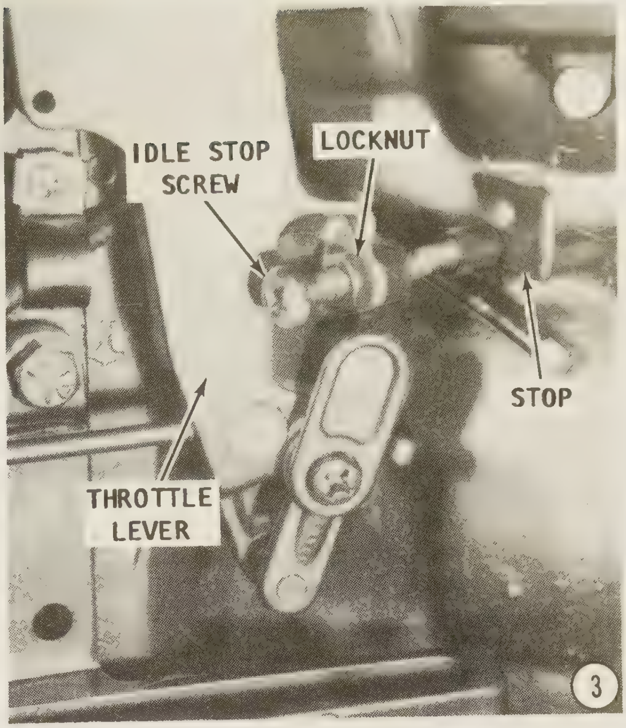
Timer Pointer Adjustment

1- Remove all spark plugs. Install a dial indicator into the No.1 (top cylinder starboard bank), spark plug opening. Slowly rotate the flywheel **CLOCKWISE** until the No. 1 piston is at top dead center (TDC). Set the dial indicator to "0". Slowly rotate the flywheel **COUNTER-CLOCKWISE** until the dial indicator needle is 1/4 turn beyond the .462" mark. Now, slowly rotate the flywheel back -- **CLOCKWISE** -- until the dial indicator is **EXACTLY** at the .462" mark. Observe the timing pointer on the flywheel cover and the .462" mark on the flywheel. If the flywheel pointer is not exactly on the mark, loosen the pointer adjustment screws and align the pointer with the .462" mark. Tighten the pointer adjustment screws and remove the dial indicator from the No. 1 spark plug opening.

Trigger Link Rod Measurement

2- If the link rod was disassembled, measure the length of the trigger link rod from the center line of the 90^0 bend to the edge of the locknut. A dimension of 11/16" (17.5mm) is required for proper timing adjustment.

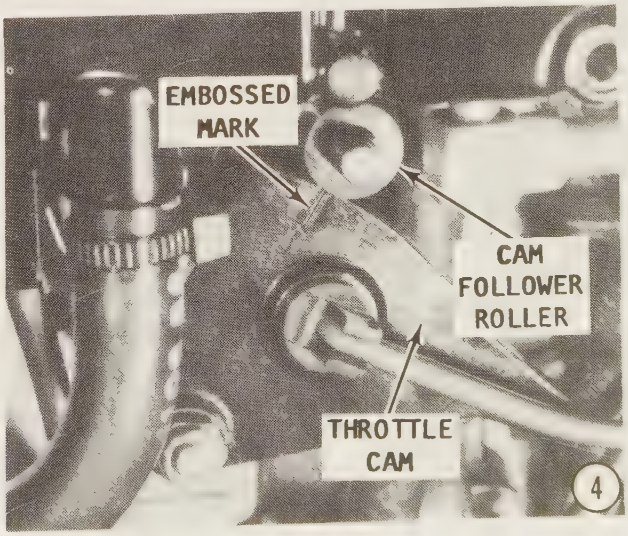


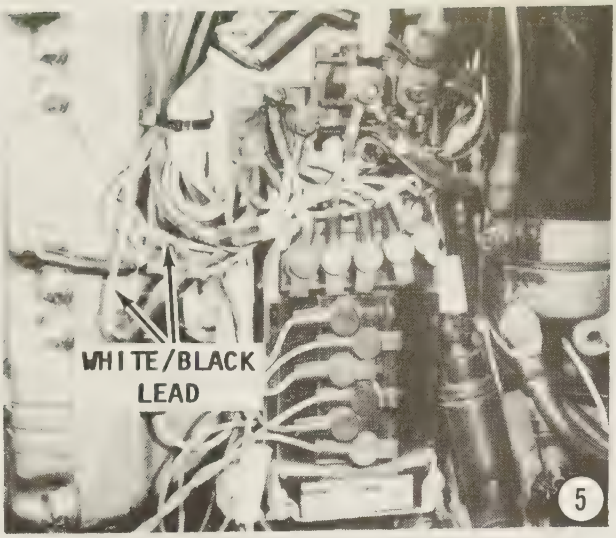


Throttle Cam Adjustment

3- Loosen the locknut on the idle stop screw. Move the throttle lever until the idle stop screw makes contact with the idle stop. Hold the throttle lever in this position for the duration of this throttle cam adjustment --thru Step 4.

4- Loosen the cam follower roller screw behind the cam. Rotate the idle stop screw until the cam follower roller contacts the throttle cam and the embossed line on the throttle cam is centered on the cam follower roller. Tighten the idle stop screw locknut and the cam follower screw with the cam follower roller barely making contact with the cam. Release the throttle lever back to the idle position.





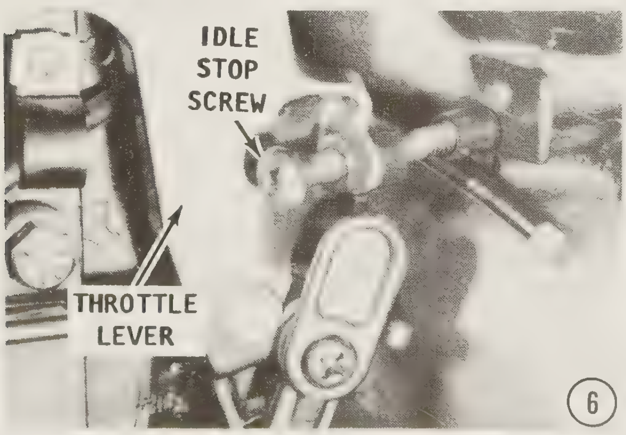
Idle Timing Adjustment at Cranking Speed

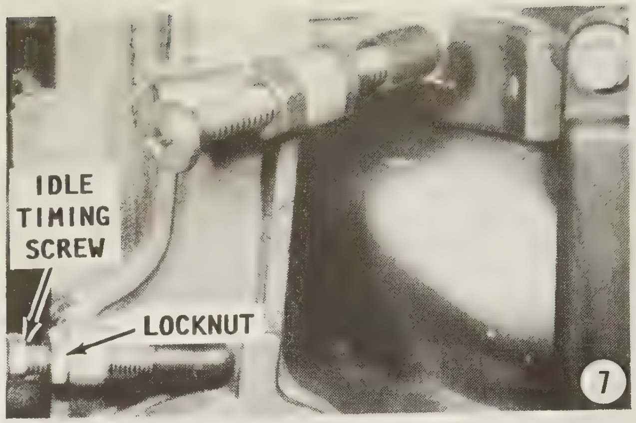
SAFETY WORDS

To prevent the powerhead from firing during the timing procedures, remove all spark plugs **EXCEPT** No. 1 (top starboard bank). Disconnect the fuel line from the powerhead fuel connector. Disconnect the remote throttle cable barrel from the barrel retainer on the port side of the powerhead.

5- Disconnect the Black/White wire lead from the idle stabilization module at the bullet connector next to the module. Wrap tape around the wire end to prevent it from shorting out. Disconnect the electronic control unit (ECU) harness connector for the ignition timing procedures. Connect a timing light to the No. 1 spark plug lead on the starboard top side.

6- Move the throttle lever until the idle stop screw contacts the idle stop. Hold the throttle lever in this position for the duration of the following step.



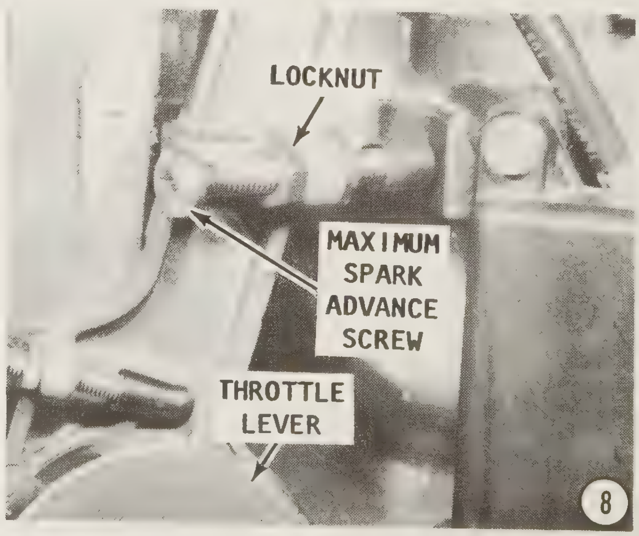


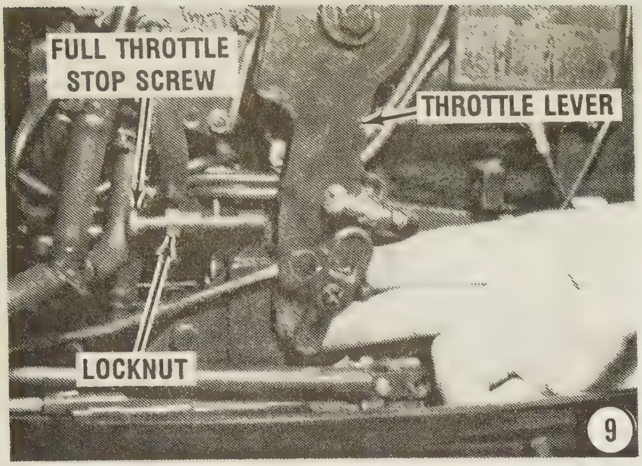
7- Loosen the locknut on the idle timing screw. Have an assistant crank the powerhead with the cranking motor and at the same time rotate the idle timing screw until the marks on the timing decal align with the timing pointer as listed in the specifications in the Appendix. Tighten the locknut on the idle timing screw to hold this adjustment. Release the throttle lever.

Maximum Timing Adjustment At Cranking Speed

8- Loosen the locknut on the maximum spark advance screw. Move the throttle lever until the maximum spark advance screw contacts the stop. Hold the throttle lever in this position for the duration of this step.

Have an assistant crank the powerhead with the cranking motor and at the same time rotate the maximum spark advance screw until the timing mark on the flywheel decal aligns with the timing pointer according to the Specifications in the Appendix. Tighten the locknut on





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the maximum spark advance screw. Set the ignition switch to **OFF** and install the remaining five spark plugs.

Maximum Throttle Adjustment -- Static (Powerhead Not Operating)

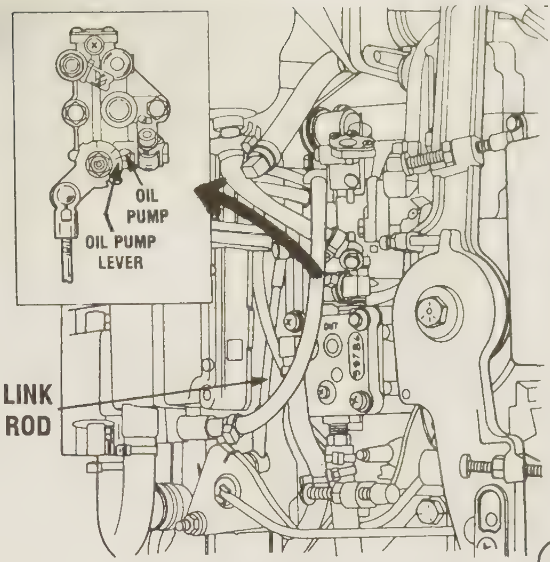
9- Loosen the locknut on the full throttle stop screw. Move the throttle lever forward until the lever contacts the full throttle stop screw. Rotate the screw until all the throttle shutters are fully open. A slight clearance should be maintained between the throttle shaft arm and the stop on the manifold. Check for free play at the cam follower roller and the throttle cam. This indicates there is no binding of the throttle linkage. Readjust the full throttle stop screw, if required.

Throttle Position Indicator (TPI) Adjustment

GOOD WORDS

The throttle position sensor (TPI) is used for low speed and mid-range power settings. The TPI transmits throttle position information to the ECU controller in the form of a low voltage signal. This low voltage signal will range from .250 VDC at the idle position to 7.VDC at WOT setting. A lower voltage setting will cause the powerhead to operate on a leaner mixture and a higher voltage will richen the fuel mixture.

Alignment and adjustment of the TPI is a critical step in the timing and synchronizing of the powerhead. This procedure requires the use of a digital meter and special in-line harness connector to monitor the TPI voltage output during throttle operation. This equipment is expensive and the procedure should **ONLY** be performed by a qualified Mercury/Mariner technician.



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Throttle Valve and Oil Pump Synchronization

10- Position and hold the throttle lever against the idle stop. Verify the alignment mark on the oil pump lever is aligned with the casting mark on the oil pump body. If not, disconnect the linkage rod from the oil pump lever. Screw the rod end, in or out, to align the oil pump lever mark with the mark on the body casting. Connect the rod end onto the oil pump lever ball.

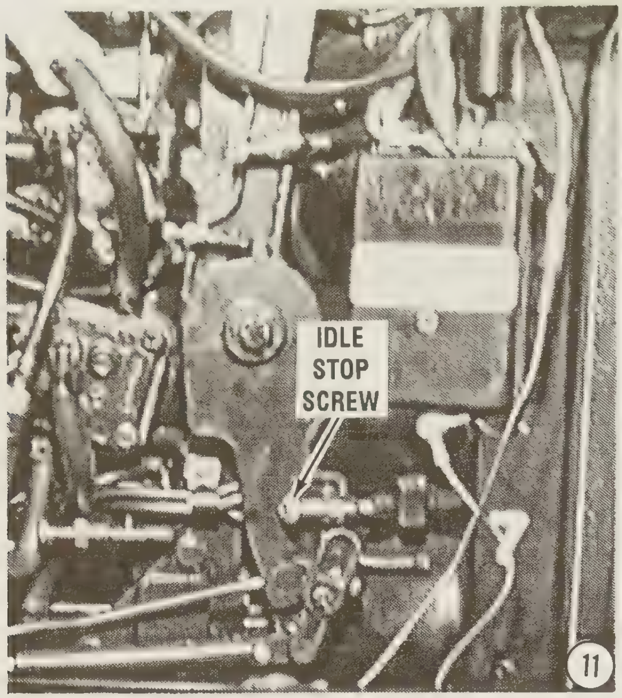
Idle Timing Adjustment -- Dynamic (Powerhead Operating)

CRITICAL WORDS

The following procedures **MUST** be performed with the outboard in a test tank or the boat and outboard in a body of water. The remaining timing procedures can only be preformed with the outboard running in **FORWARD** gear and the propeller under an actual load condition. A proper adjustment **CANNOT** be made with a flush device attached to the lower unit.

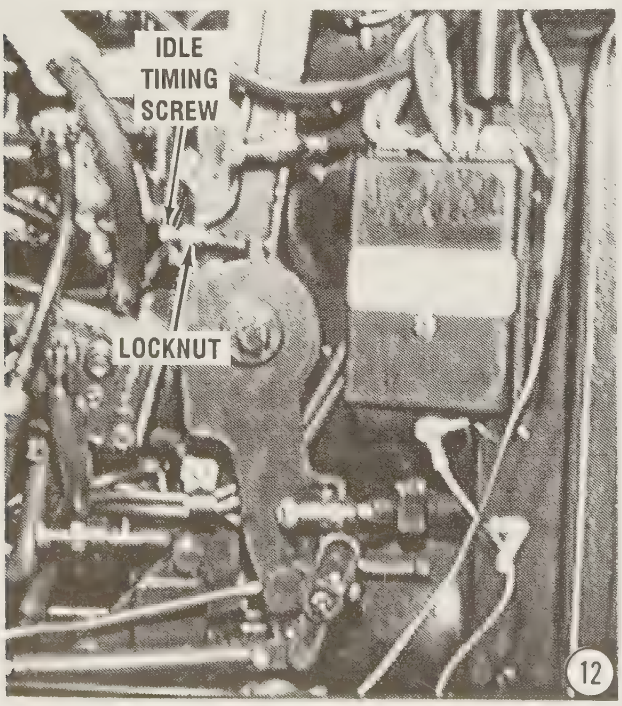
CAUTION

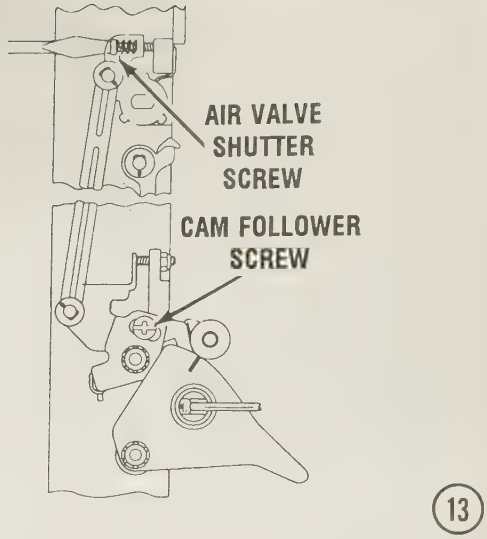
Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.



11- With the outboard unit mounted in a test tank or the craft and outboard in a body of water, start the powerhead and allow it to warm to operating temperature. Shift the unit into **FORWARD** gear. Keep the powerhead rpm below 750 rpm.

With the throttle cable "barrel" removed from the retainer, move the throttle lever until the idle stop screw contacts the idle stop. Hold the lever in this position for the duration of the following step.





12- Connect a timing light to the No. 1 spark plug high tension lead. Loosen the locknut on the idle timing screw. Aim the timing light at the timing decal and rotate the idle timing screw until the marks on the timing decal align with the timing pointer according to the Specifications in the Appendix. Tighten the locknut on the idle timing screw to hold this adjustment.

Connect the White/Black lead on the idle stabilization module at the bullet connector next to the module.

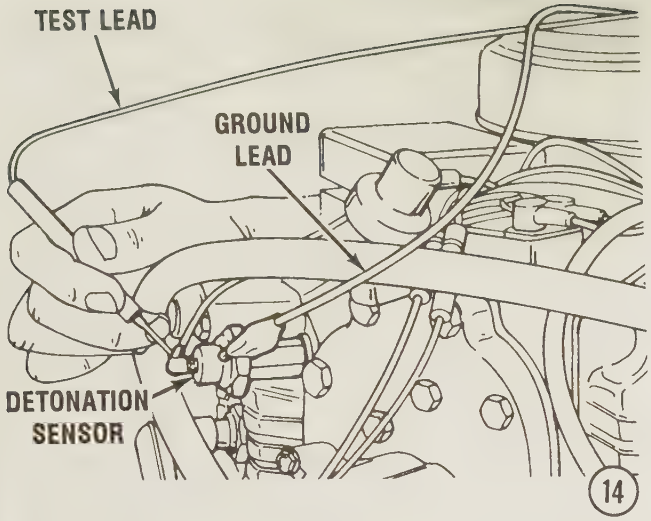
Idle Speed Adjustment -- Dynamic (Powerhead Operating)

13- Mount the outboard unit in a test tank or the craft and outboard in a body of water. Connect a tachometer to the rectifier Gray wire or the terminal block Yellow wire. Start the powerhead and allow it to warm to operating temperature. Loosen the screw on the cam follower. Hold the throttle lever against the idle stop screw. Adjust the idle speed to the Specifications in the Appendix by increasing or decreasing the air valve opening. Tighten the screw on the cam follower.

Maximum Timing Adjustment -- Dynamic (Powerhead Operating)

14- On models 200hp **ONLY**, disconnect the White/Blue lead from the detonation sensor on the port side cylinder head.

15- Connect a timing light to the No. 1 cylinder spark plug wire. Mount the outboard unit in a test tank or the craft and outboard in a body of water. Start the powerhead and allow



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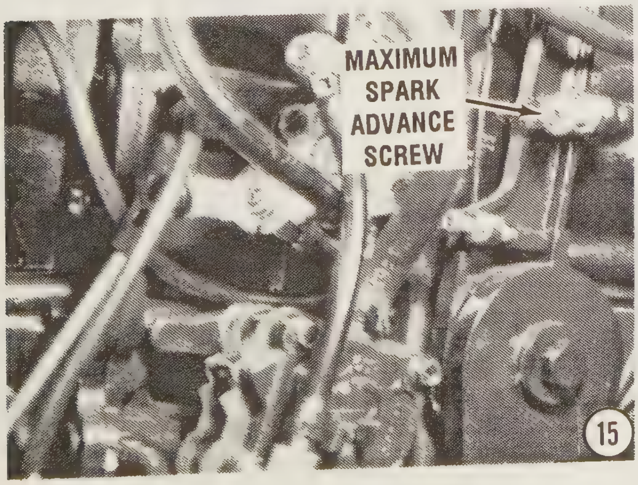
it to warm to operating temperature. Shift the unit into **FORWARD** gear. Move the throttle lever forward until the maximum spark adjustment screw contacts the stop. This contact should occur when the powerhead approaches 2500 rpm. Adjust the maximum spark adjustment screw to align the timing mark on the decal with the timing pointer according to the Specifications in the Appendix. Tighten the locknut to hold the adjustment.

Return the throttle lever to the idle position and shift the unit into **NEUTRAL**. Shut down the powerhead; disconnect the timing light; and reconnect the White/Blue lead to the detonation sensor.

Detonation Control System
Model 200hp Only

16- Connect a timing light to the No. 1 cylinder spark plug lead. Connect a tachometer to the rectifier Gray wire or the terminal block Yellow wire.

Mount the outboard unit in a test tank or the craft and outboard in a body of water. Start



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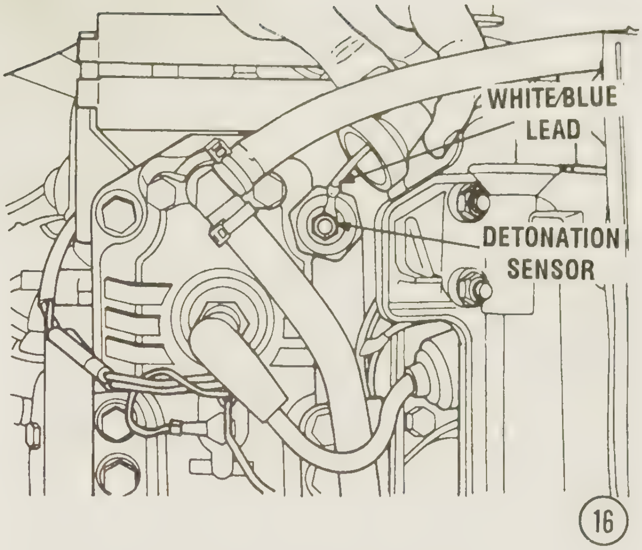

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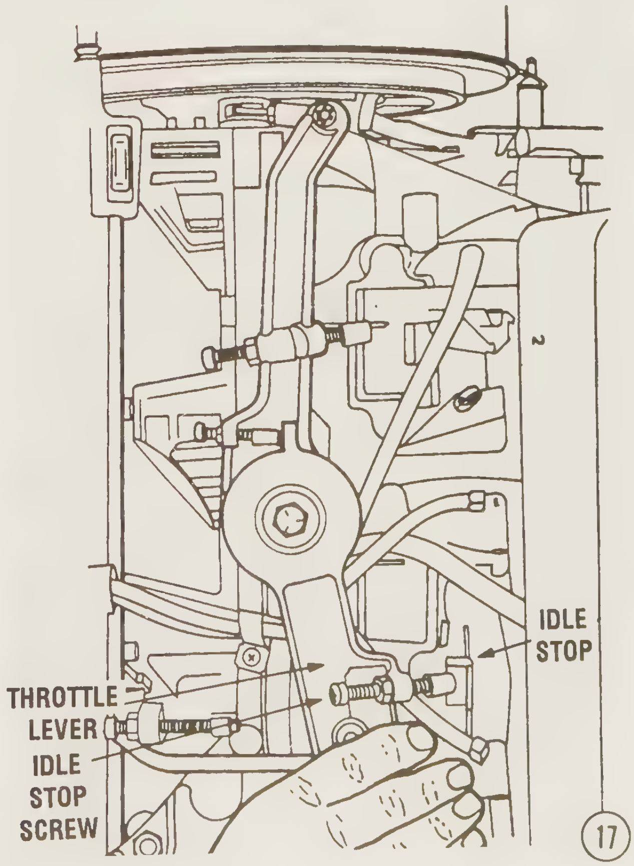
the powerhead and allow it to warm to operating temperature. Shift the unit into **FORWARD** gear. Move the throttle lever forward until the powerhead indicates 3500 rpm on the tachometer. Verify the timing has been electronically advanced to 26^0 BTDC. The advancement indicates the detonation (knock), control circuit is functioning properly.



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Return the throttle lever to the idle position and shift the outboard into **NEUTRAL**. Shut down the powerhead, and then disconnect the timing light and tachometer.

Throttle Cable Preload Adjustment

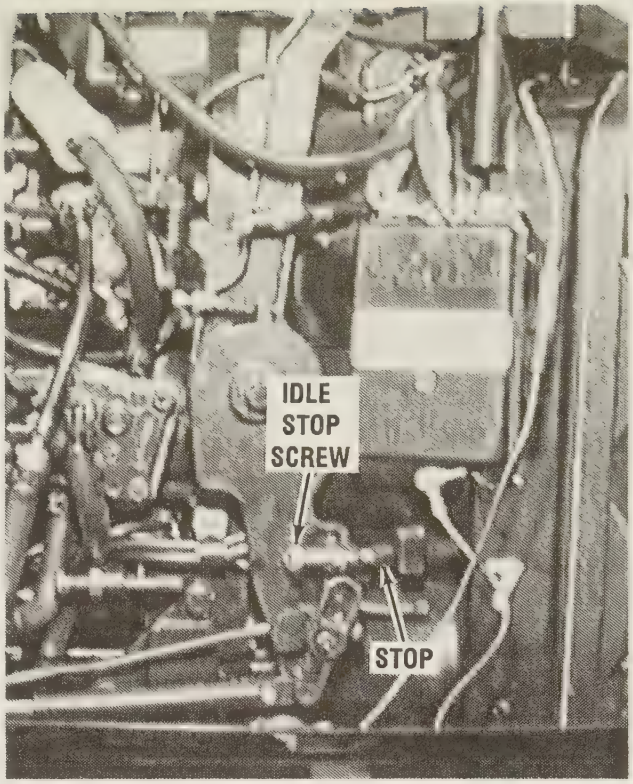
17- Connect the end of the throttle cable to the throttle lever. Move the throttle lever forward against the idle stop screw. Adjust the throttle cable barrel until it will slip into the barrel recess in the control cable anchor bracket with **ONLY** a light preload against the idle stop.

Lock the throttle cable barrel into the barrel recess on the control cable anchor bracket.

BAD NEWS

An excessive preload on the throttle cable will cause difficulty when shifting from **FORWARD** gear into **NEUTRAL**.

The preload may be easily checked by placing a piece of paper between the idle stop screw and the idle stop, and then withdrawing it. If the paper does not tear, but drag can be felt, the preload is correct. Adjust the cable barrel, if necessary, to obtain the proper preload just described. Install the powerhead cowling.



If a piece of paper is inserted between the idle stop screw and the stop -- before the adjustment is made and then the paper withdrawn with just a bit of "drag" after the adjustment -- the preload adjustment is correct.

7 ELECTRICAL

7-1 INTRODUCTION

The battery, gauges, horns, charging system, and the cranking system are all considered subsystems of the electrical system. Each of these units or subsystems will be covered in detail in this chapter beginning with the battery.

7-2 BATTERIES

The battery is one of the most important parts of the electrical system. In addition to providing electrical power to start the engine, it also provides power for operation of the running lights, radio, electrical accessories, and possibly the pump for a bait tank.

Because of its job and the consequences, (failure to perform in an emergency) the best advice is to purchase a well-known brand, with an extended warranty period, from a reputable dealer.

The usual warranty covers a prorated replacement policy, which means you would be entitled to a consideration for the time left on the warranty period if the battery should prove defective before its time.

The 2-cycle outboard powerheads covered in this manual require a 12-volt battery with a **"Cold Cranking Amperage"** rating of 350 amperes for cranking and a minimum **"Reserve Capacity"** of 100 minutes. If in doubt, estimate requirements and then purchase the next higher ampere rating.

MARINE BATTERIES

Because marine batteries are required to perform under much more rigorous conditions than automotive batteries, they are constructed much differently than those used in automobiles or trucks. Therefore, a marine battery should always be the No. 1 unit for the boat and other types of batteries used only in an emergency.

Marine batteries have a much heavier exterior case to withstand the violent pounding and shocks imposed on it as the boat moves through rough water and in extremely tight turns.

The plates in marine batteries are thicker than in automotive batteries and each plate is securely anchored within the battery case to ensure extended life.

The caps of marine batteries are "spill proof" to prevent acid from spilling into the bilges when the boat heels to one side in a tight turn, or is moving through rough water.

Because of these features, the marine battery will recover from a low charge condition and give satisfactory service over

A fully charged battery, filled to the proper level with electrolyte, is the heart of the ignition and electrical systems. Engine cranking and efficient performance of electrical items depend on a full-rated battery.

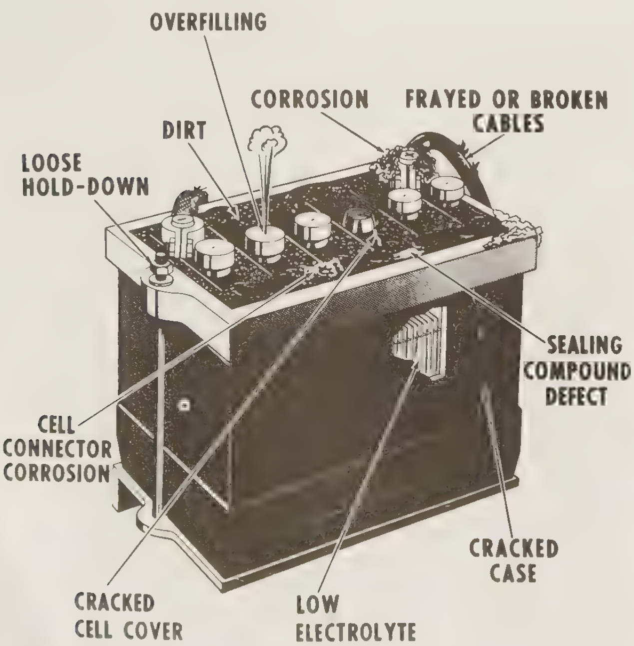
a much longer period of time than any type intended for automotive use.

NEVER use a "Maintenance Free" type battery with an outboard unit. The charging system is not regulated as with automotive installations and the battery may be quickly damaged.

BATTERY CONSTRUCTION

A battery consists of a number of positive and negative plates immersed in a solution of diluted sulfuric acid. The plates contain dissimilar active materials and are kept apart by separators. The plates are grouped into what are termed elements. Plate straps on top of each element connect all of the positive plates and all of the negative plates into groups.

The battery is divided into cells which hold a number of the elements apart from the others. The entire arrangement is contained within a hard-rubber case. The top is a one-piece cover and contains the filler caps for each cell. The terminal posts protrude through the top where the battery connections for the boat are made. Each of the cells is connected to its neighbor in a positive-to-negative manner with a heavy strap called the cell connector.



A visual inspection of the battery should be made each time the boat is used. Such a quick check may reveal a potential problem in its early stages. A dead battery in a busy waterway or far from assistance could have serious consequences.

BATTERY RATINGS

Four different methods are used to measure and indicate battery electrical capacity:

1- Ampere-hour rating
2- Cold cranking performance
3- Reserve capacity
4- Watt hour rating

The **ampere-hour** rating of a battery refers to the battery's ability to provide a set amount of amperes for a given amount of time under test conditions at a constant temperature of 80°F (27°C). Amperes x hours equals ampere-hour rating. Therefore, if the battery is capable of supplying 4 amperes of current for 20 consecutive hours, the battery is rated as an 80 ampere-hour battery.

The ampere-hour rating is useful for some service operations, such as slow charging or battery testing.

Cold cranking performance is measured by cooling a fully charged battery to 0°F (-17°C) and then testing it for 30 seconds to determine the maximum current flow. In this manner the cold cranking amperes rating is the number of amperes available to be drawn from the battery before the voltage drops below 7.2 volts.

The small added expense of a top quality battery switch with a key lock is well worth the investment.

Reserve capacity of a battery is considered the length of time -- in minutes -- at 80°F (27°C) a 25 ampere current can be maintained before the voltage drops below 10.5 volts. This test is intended to provide an approximation of how long the engine, including electrical accessories such as bilge pump, radio, running light, could continue to operate satisfactorily if the alternator or magneto did not produce sufficient current. A typical rating is 100 minutes.

Watt-hour is a very useful rating of battery power. It is determined by multiplying the number of ampere hours times the voltage. Therefore, a 12-volt battery rated at 80 ampere-hours would be rated at 960 watt-hours (80 x 12 = 960).

If possible, the new battery should have a power rating equal to or higher than the unit it is replacing.

BATTERY LOCATION

Every battery installed in a boat must be secured in a well-protected ventilated area. If the battery area lacks adequate ventilation, hydrogen gas which is given off during charging could become very explosive. This is especially true if the gas is concentrated and confined.

BATTERY SERVICE

The battery requires periodic servicing and a definite maintenance program will ensure extended life. If the battery should test satisfactorily, but still fails to perform properly, one of five problems could be the cause.

1- An accessory might have accidently been left on overnight or for a long period during the day. Such an oversight would result in a discharged battery.

2- Slow speed engine operation for long periods of time resulting in an undercharged condition.

3- Using more electrical power than the alternator can replace would result in an undercharged condition.

4- A defect in the charging system. A faulty alternator, defective rectifier, or high resistance somewhere in the system could cause the battery to become undercharged.

5- Failure to maintain the battery in good order. This might include a low level of electrolyte in the cells; loose or dirty cable connections at the battery terminals; or possibly an excessively dirty battery top.

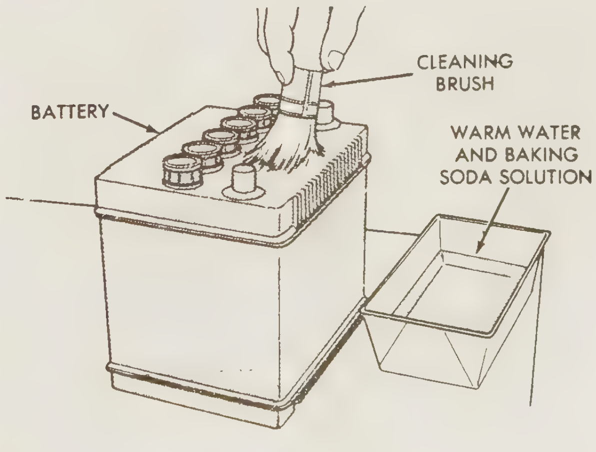
Electrolyte Level

The most common practice of checking the electrolyte level in a battery is to remove the cell cap and visually observe the level in the vent well. The bottom of each vent well has a split vent which will cause the surface of the electrolyte to appear distorted when it makes contact. When the distortion first appears at the bottom of the split vent, the electrolyte level is correct.

Some late-model batteries have an electrolyte-level indicator installed which operates in the following manner:

A transparent rod extends through the center of one of the cell caps. The lower tip of the rod is immersed in the electrolyte when the level is correct. If the level should drop below normal, the lower tip of the rod is exposed and the upper end glows as a warning to add water. Such a device is only necessary on one cell cap because if the electrolyte is low in one cell it is also low in the other cells. **BE SURE** to replace the cap with the indicator onto the second cell from the positive terminal.

During hot weather and periods of heavy use, the electrolyte level should be checked more often than during normal operation. Add potable (drinking) water to bring the level of electrolyte in each cell to the proper level. **TAKE CARE** not to overfill, because adding an excessive amount of water will cause loss of electrolyte and any loss will result in poor performance, short battery life, and will contribute quickly to corrosion. **NEVER** add electrolyte from another battery. Use only clean pure water.

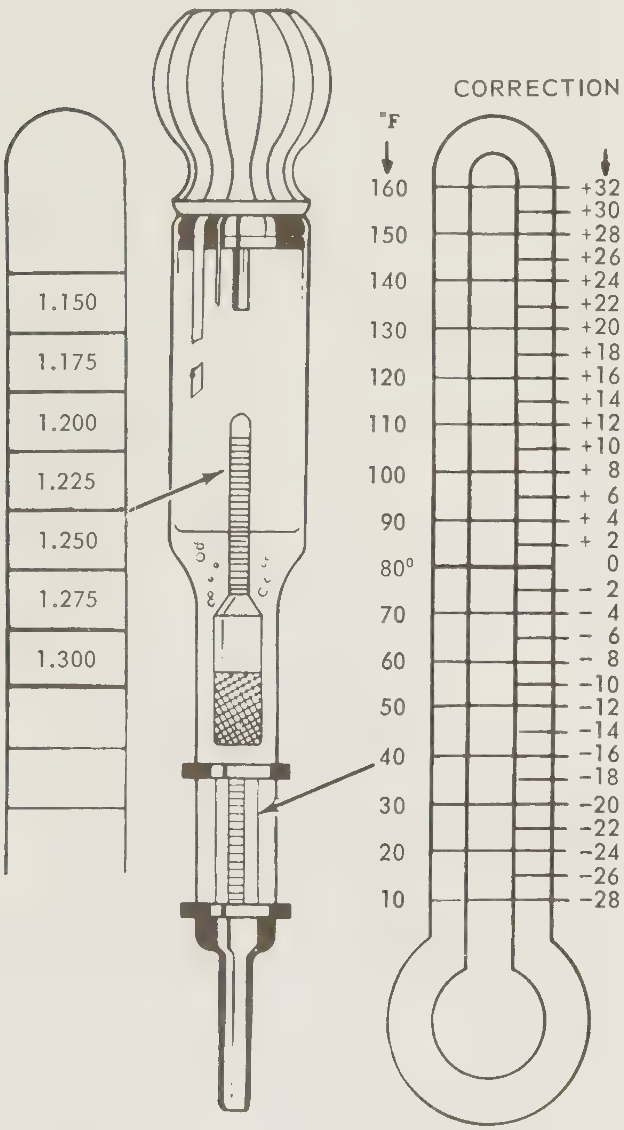


The battery top should be kept clean. A water and baking soda solution applied with a brush will neutralize battery electrolyte and clean the top nicely.

Battery Testing

A hydrometer is a device to measure the percentage of sulfuric acid in the battery electrolyte in terms of specific gravity. When the condition of the battery drops from fully charged to discharged, the acid leaves the solution and enters the plates, causing the specific gravity of the electrolyte to drop.

It may not be common knowledge, but hydrometer floats are calibrated for use at 80°F (27°C). If the hydrometer is used at any other temperature, hotter or colder, a correction factor must be applied. (Remember, a liquid will expand if it is heated and will contract if cooled. Such expansion and contraction will cause a definite change in the specific gravity of the liquid, in this case the electrolyte.)



A check of the electrolyte in the battery should be on the maintenance schedule for any boat. A hydrometer reading of 1.300, or in the green band, indicates the battery is in satisfactory condition. If the reading is 1.150 or in the red band, the battery must be charged. Observe the six safety points listed in the text when using a hydrometer.

A quality hydrometer will have a thermometer/temperature correction table in the lower portion, as shown in the accompanying illustration. By knowing the air temperature around the battery and from the table, a correction factor may be applied to the specific gravity reading of the hydrometer float. In this manner, an accurate determination may be made as to the condition of the battery.

The following six points should be observed when using a hydrometer.

1- **NEVER** attempt to take a reading immediately after adding water to the battery. Allow at least 1/4 hour of charging at a high rate to thoroughly mix the electrolyte with the new water. This time will also allow for the necessary gasses to be created.

2- **ALWAYS** be sure the hydrometer is clean inside and out as a precaution against contaminating the electrolyte.

3- If a thermometer is an integral part of the hydrometer, draw liquid into it several times to ensure the correct temperature before taking a reading.

4- **BE SURE** to hold the hydrometer vertically and suck up liquid only until the float is free and floating.

5- **ALWAYS** hold the hydrometer at eye level and take the reading at the surface of the liquid with the float free and floating.

Disregard the light curvature appearing where the liquid rises against the float stem. This phenomenon is due to surface tension.

6- **DO NOT** drop any of the battery fluid on the boat or on your clothing, because it is extremely caustic. Use water and baking soda to neutralize any battery liquid that does accidently drop.

After withdrawing electrolyte from the battery cell until the float is barely free, note the level of the liquid inside the hydrometer. If the level is within the green band range for all cells, the condition of the battery is satisfactory. If the level is within the white band for all cells, the battery is in fair condition.

If the level is within the green or white band for all cells except one, which registers in the red, the cell is shorted internally.

No amount of charging will bring the battery back to satisfactory condition.

If the level in all cells is about the same, even if it falls in the red band, the battery may be recharged and returned to service. If the level fails to rise above the red band after charging, the only solution is to replace the battery.

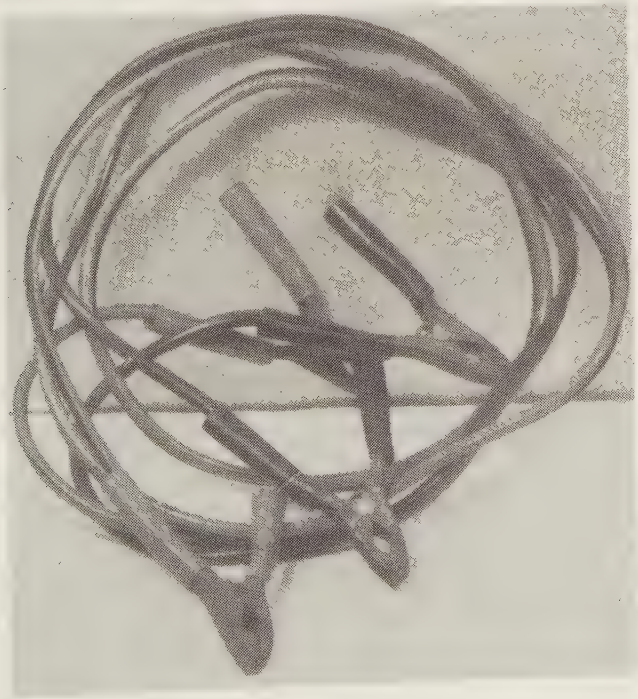
Cleaning

Dirt and corrosion should be cleaned from the battery just as soon as it is discovered. Any accumulation of acid film or dirt will permit current to flow between the terminals. Such a current flow will drain the battery over a period of time.

Clean the exterior of the battery with a solution of diluted ammonia or a soda solution to neutralize any acid which may be present. Flush the cleaning solution off with clean water. **TAKE CARE** to prevent any of the neutralizing solution from entering the cells, by keeping the caps tight.

A poor contact at the terminals will add resistance to the charging circuit. This resistance will cause the voltage regulator to register a fully charged battery, and thus cut down on the alternator output adding to the low battery charge problem.

Scrape the battery posts clean with a suitable tool or with a stiff wire brush.



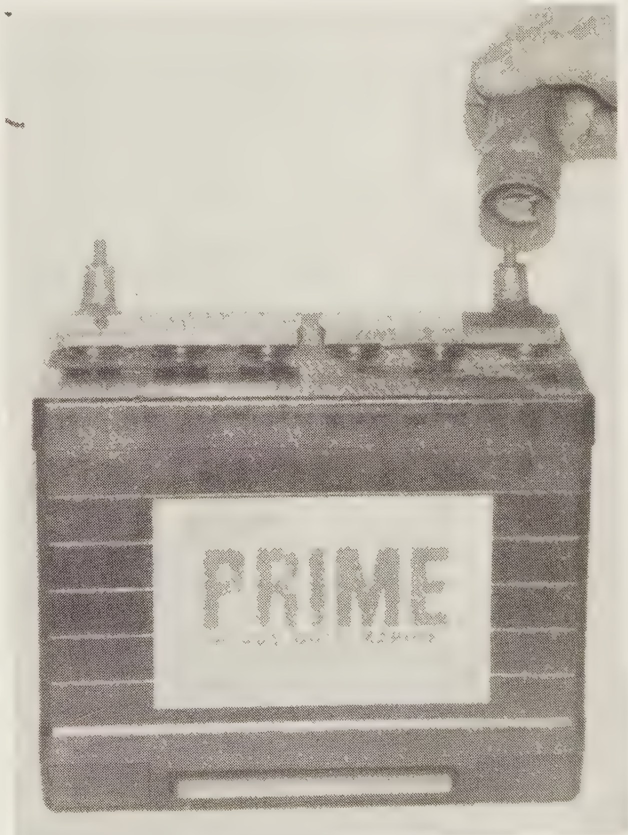
A common set of heavy-duty jumper cables. The booster battery must be connected correctly and in the proper sequence, as outlined in the text, to prevent damage to the battery or to the alternator diodes.

An inexpensive two-part tool will do an excellent job of cleaning the battery terminals and the inside of the cable connectors.

Clean the inside of the cable clamps to be sure they do not cause any resistance in the circuit.

JUMPER CABLES

If booster batteries are used for starting an engine the jumper cables must be connected correctly and in the proper sequence to prevent damage to either battery, or to the alternator diodes.



An inexpensive two-part brush can be purchased and used to clean both the battery cable connectors (top) and the battery terminals (bottom).

ALWAYS connect a cable from the positive terminal of the dead battery to the positive terminal of the good battery **FIRST. NEXT,** connect one end of the other cable to the negative terminal of the good battery and the other end to a good ground on the powerhead. **DO NOT** connect the negative jumper from the good battery to the negative terminal of the low battery. Such action will almost always cause a spark which could ignite gases escaping through the vent holes in the battery filler caps. Igniting the gases may result in an explosion destroying the battery and causing severe personal **INJURY.**

By making the negative (ground) connection on the powerhead, if an arc is created, it will not be near the battery.

DISCONNECT the battery ground cable before replacing an alternator or before connecting any type of meter to the alternator.

If it is necessary to use a fast-charger on a dead battery, **ALWAYS** disconnect one of the boat cables from the battery **FIRST,** to prevent burning out the diodes in the rectifier.

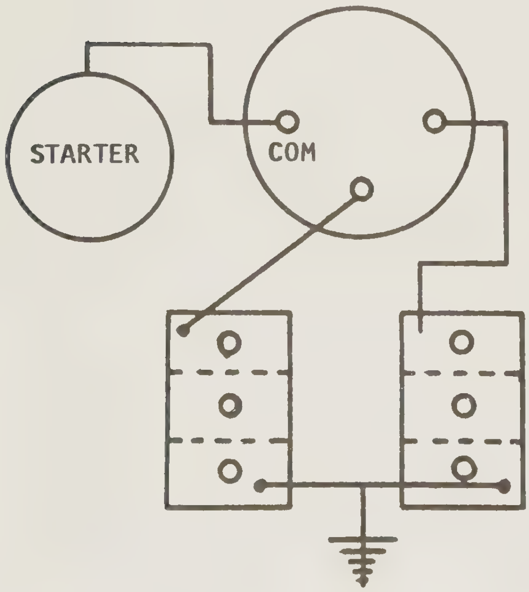
NEVER use a fast-charger as a booster to start the engine because the diodes in the alternator will be **DAMAGED.**

STORAGE

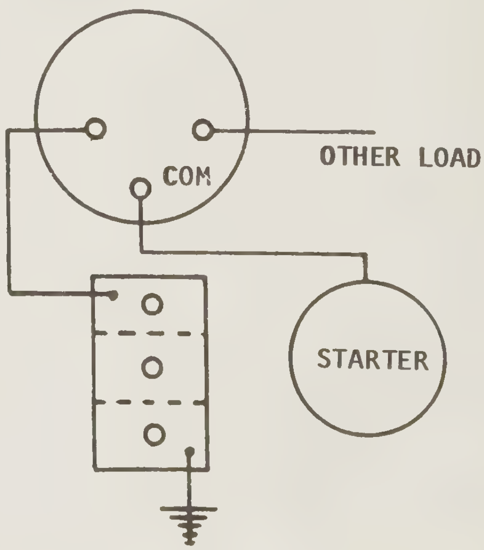
If the boat is to be laid up for the winter or for more than a few weeks, special attention must be given to the battery to prevent complete discharge or possible damage to the terminals and wiring. Before putting the boat in storage, disconnect and remove the batteries. Clean them thoroughly of any dirt or corrosion, and then charge them to full specific gravity reading. After they are fully charged, store them in a clean cool dry place where they will not be damaged or knocked over, preferably on a couple blocks of wood. Storing the battery up off the deck, will permit air to circulate freely around and under the battery and will help to prevent condensation.

NEVER store the battery with anything on top of it or cover the battery in such a manner as to prevent air from circulating around the fillercaps. All batteries, both new and old, will discharge during periods of storage, more so if they are hot than if they remain cool. Therefore, the electrolyte level and the specific gravity should be checked at regular intervals. A drop in the specific gravity reading is cause to charge them back to a full reading.

In cold climates, care should be exercised in selecting the battery storage area.



Schematic drawing for a two battery, one engine installation.



Schematic drawing for a single battery, one engine installation.

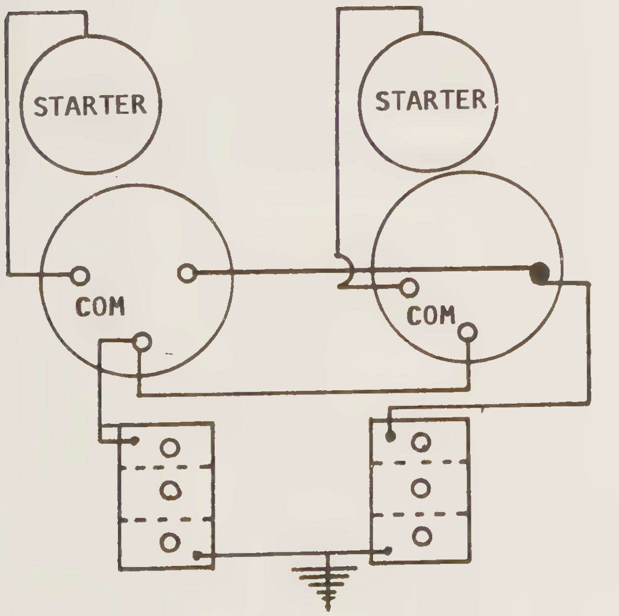
A fully-charged battery will freeze at about 60 degrees below zero. A discharged battery, almost dead, will have ice forming at about 19 degrees above zero.

DUAL BATTERY INSTALLATION

Three methods are available for utilizing a dual-battery hook-up.

1- A high-capacity switch can be used to connect the two batteries. The accompanying illustration details the connections for installation of such a switch. This type of switch installation has the advantage of being simple, inexpensive, and easy to mount and hookup. However, if the switch is accidently left in the closed position, it will cause the convenience loads to run down both batteries and the advantage of the dual installation is lost. The switch may be closed intentionally to take advantage of the extra capacity of the two batteries, or it may be temporarily closed to help start the engine under adverse conditions.

2- A relay, can be connected into the ignition circuit to enable both batteries to be automatically put in parallel for charging or to isolate them for ignition use during engine cranking and start. By connecting the relay coil to the ignition terminal of the ignition-starting switch, the relay will close during the start to aid the starting battery.



Schematic drawing for a two battery, two engine installation.

If the second battery is allowed to run down, this arrangement can be a disadvantage since it will draw a load from the starting battery while cranking the engine.

One way to avoid such a condition is to connect the relay coil to the ignition switch accessory terminal. When connected in this manner, while the engine is being cranked, the relay is open. But when the engine is running with the ignition switch in the normal position, the relay is closed, and the second battery is being charged at the same time as the starting battery.

3- A heavy duty switch installed as close to the batteries as possible can be connected between them. If such an arrangement is used, it must meet the standards of the American Boat and Yacht Council, INC. or the Fire Protection Standard for Motor Craft, N.F.P.A. No. 302.

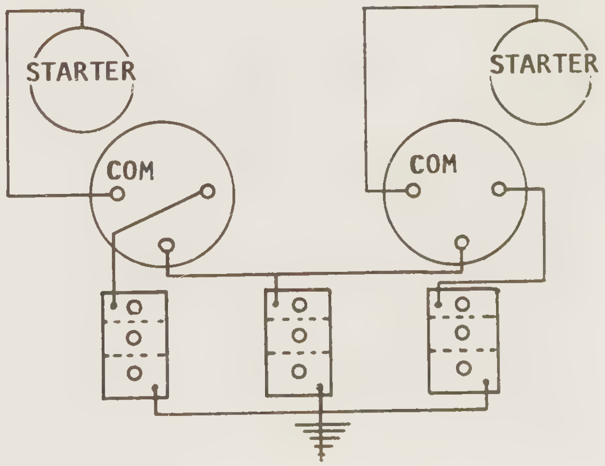
7-3 FUEL, OIL, AND TEMPERATURE SENSORS AND GAUGES

The most important part of embarking on a boating excursion is to be sure sufficient fuel and oil is aboard for the day's activities. While underway, the powerhead temperature is probably the next most important item to monitor. The following text and illustrations describe operation and troubleshooting of the most common problems related to these systems.

CONSTANT VOLTAGE SYSTEM

FIRST, THESE WORDS

The powerhead manufacturer sends their units "out the door" with a 12-volt gauge system.



Schematic drawing of a three battery, two engine installation.

HOWEVER, some boat manufacturers prefer to use a constant voltage system. The following paragraphs briefly describe a constant voltage system. This information is provided as a "courtesy" to the reader, because it is not a "stock" system.

In order for gauges in a constant voltage system to register properly, they must be supplied with a steady voltage. The voltage variations produced by the powerhead charging system would cause erratic gauge operation, too high when the alternator voltage is high and too low when the alternator is not charging. To remedy this problem a constant voltage system is used to reduce the 12-14 volts of the electrical system to an average of 5-volts. This steady 5-volts ensures the gauges will read accurately under varying conditions from the electrical system. If other accessories seem to have a higher voltage than necessary -- lights burning too brightly -- a faulty voltage regulator is indicated.

Service Procedures

Systems utilizing warning lights do not require a constant voltage system, therefore, this service is not needed.

Service procedures for checking the gauges and their sending units in a 12-volt gauge system are detailed in various sections of this chapter.

FUEL GAUGES

The fuel gauge is intended to indicate the quantity of fuel in the tank. As most experienced boat people have learned, the gauge reading is seldom an accurate indication of total volume of fuel in the tank. The boat is seldom on a even keel while underway, thus the gauge will give a false reading. A considerable difference in fuel quantity will be indicated by the gauge if the bow or stern is heavy, or if the boat has a list to port or starboard.

The gauges, indicator lights, and other instruments on the control panel should be kept clean and protected from water spray as much as practical. This is especially important when operating in salt water.

Therefore, the reading is usually low. The amount of fuel drawn from the tank is dependent on the location of the fuel pickup tube in the tank. The powerhead may cutout while cruising because the pickup tube is above the fuel level. Instead of assuming the tank is empty, shift weight in the boat to change the trim and the problem may be solved until more fuel is taken aboard.

Fuel Gauge Hookup

The National Marine Manufacturers Association (NMMA), recommends the following color coding be used on all fuel gauge installations.

Black -- for all grounded current carrying conductors.

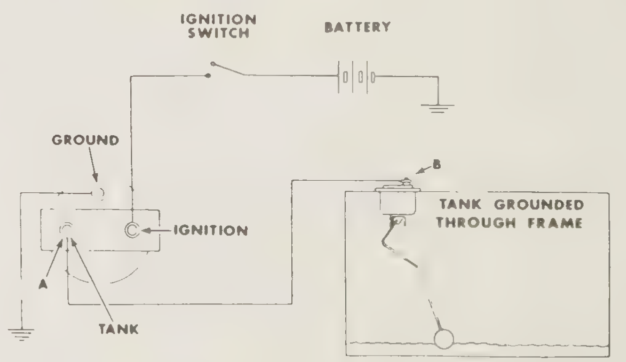
Pink -- insulated wire between the fuel sending unit and the gauge.

Red -- insulated wire for a connection from the positive side of the battery to any electrical equipment.

Connect one end of a Pink insulated wire to the terminal on the gauge marked **TANK** and the other end to the terminal on top of the tank unit.

Connect one end of a Red wire to the terminal on the fuel gauge marked **IGN** and the other end to the ignition switch.

Connect one end of the Black wire to the fuel gauge terminal marked **GRD** and the other end to a good ground. It is important for the fuel gauge case to have a good common ground with the tank unit. Aboard an all-metal boat, this ground wire is not necessary. However, if



Schematic diagram for a safe fuel tank gauge hookup. The tank must be grounded either through the frame or with a separate grounding strap.

the control panel is insulated, or made of wood or plastic, a wire **MUST** be run from the gauge ground terminal to one of the bolts securing the sending unit in the fuel tank, and then from there to the **NEGATIVE** side of the battery.

Fuel Gauge Troubleshooting

In order for the fuel gauge to operate properly, the sending unit and the receiving unit must be of the same type and preferably by the same manufacturer.

The following symptoms and possible corrective actions will be helpful in restoring a faulty fuel gauge circuit to proper operation.

If the gauge is suspected of not operating properly, the first area to check is all electrical connections from one end of the circuit to the other. Check to be sure the connections are clean and secure.

Next, check the common ground wire between the negative side of the battery, the fuel tank, and the gauge on the control panel.

If all wires and connections in the circuit are in good condition, remove the sending unit from the tank. Connect one end of a wire to the gauge mounting flange on the tank and the other end to the flange of the sending unit. Now, move the float up-and-down to determine if the receiving unit operates. If the sending unit does not appear to operate, move the float to the midway point of its travel and observe if the receiving unit indicates a half full tank.

If the pointer does not move from the **EMPTY** position one of four faults could be to blame.

1- The control panel receiving unit is not properly grounded.

2- No voltage at the control panel receiving unit.

3- Negative meter connection is on a positive grounded system.

4- Positive meter connection is on a negative grounded system.

If the pointer fails to move from the **FULL** position, the problem could be one of three faults.

1- The tank sending unit is not properly grounded.

2- Improper connection between the tank sending unit and the receiving unit on the control panel.

3- The wire from the gauge to the ignition switch is connected at the wrong terminal.

If the pointer remains at the 3/4 full mark, a six-volt gauge is probably installed in a 12-volt system.

If the pointer remains at or about the 3/8 full position, a 12-volt gauge is probably installed in a 6-volt system.

Preliminary Inspection

Inspect all wiring in the circuit for possible damage to the insulation or conductor. Carefully check the following areas:

1- Ground connections at the receiving unit on the control panel.

2- Harness connector to the control panel.

3- Wire harness connector to the fuel tank sending unit.

4- Ground connection from the fuel tank to the battery negative terminal.

5- Feed wire connection at the tank sending unit.

Gauge Always Indicates Full Tank When Ignition Switch Is ON

1- Check electrical connections at the receiving unit on the control panel and the tank unit connector at the tank.

2- Make a continuity check of the ground wire from the tank to the negative terminal of the battery.

3- Connect a known good tank unit to the tank feed wire and the ground lead. Raise and lower the float and observe the receiving unit at the control panel. If the control panel unit follows the arm movement, replace the tank sending unit.

Gauge Always Reads Empty When Switch Is ON

Disconnect the tank unit sending wire and do not allow the wire terminal to ground. The gauge on the control panel should read full.

1- If gauge indicates tank is **EMPTY**, connect a spare control panel unit into the control panel unit harness connector and ground the unit. If the spare unit indicates tank **FULL**, the original unit is shorted and **MUST** be replaced.

2- If the gauge indicates tank is **EMPTY** in Step 1, a short must exist in the harness between the tank sending unit and the gauge on the control panel.

3- If the gauge indicates tank is **FULL** in Step 1, connect a known good tank sending unit to the tank feed wire and the ground lead.

Raise and lower the float while observing the control panel gauge. If the control panel gauge follows movement of the float, replace the tank sending unit.

Gauge Never Indicates A Full Tank

The following test requires shop test equipment.

First, disconnect the feed wire to the tank unit and connect the wire to a good ground through a variable resistor or through a spare tank unit.

Next, observe the control panel gauge reading. The gauge should indicate a **FULL** tank when resistance is increased to about 90 ohms. This amount of resistance would simulate a full tank.

If the test indicates the control panel gauge is operating properly, the trouble is either in the tank sending unit -- rheostat is shorted -- or the float is binding. The arm could be bent, or the tank may be deformed. Inspect and correct the problem.

OIL QUANTITY INDICATOR

All outboards covered in this manual are equipped with the Mercury/Mariner "Oil Injection System". This means, oil is drawn from a remote mounted oil tank and mixed with the powerhead fuel system via a mechanically driven oil pump. Two oil tanks, one fairly large, is usually mounted in the stern of the boat close to the transom. The second tank, referred to as the reservoir, is mounted on the powerhead over the carburetors. Both oil tanks are made from a translucent white plastic material so a visual indication of the oil quantity can quickly be determined.

Oil is moved from the main tank to the reservoir by crankcase pressure through a hose with a one way check valve.

An audible alarm system is incorporated in the system to warn the operator when the oil level in the reservoir drops -- leaving only about one quart (.95 liter) remaining. Such a condition means oil in the main tank has dropped below the pickup tube. The low oil condition warning is accomplished through a float switch mounted in the reservoir oil tank cap. When the float descends to a predetermined level, a signal is sent directly to the Warning Module mounted on the powerhead.

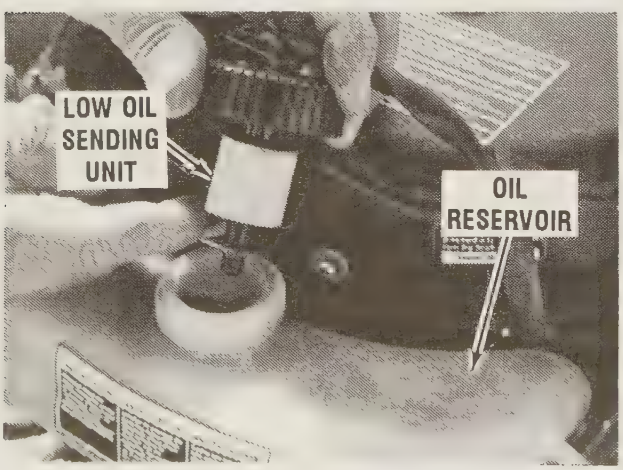
The warning module completes the circuit and the horn in the remote control shift box sounds. In most cases there is sufficient running time -- approximately 30 to 35 minutes at full throttle -- for the operator to return to shore and service the main oil tank in the boat.

As mentioned earlier, all models are equipped with a Warning Module or ECU warning system. The following is a brief operational description of the Warning Module System.

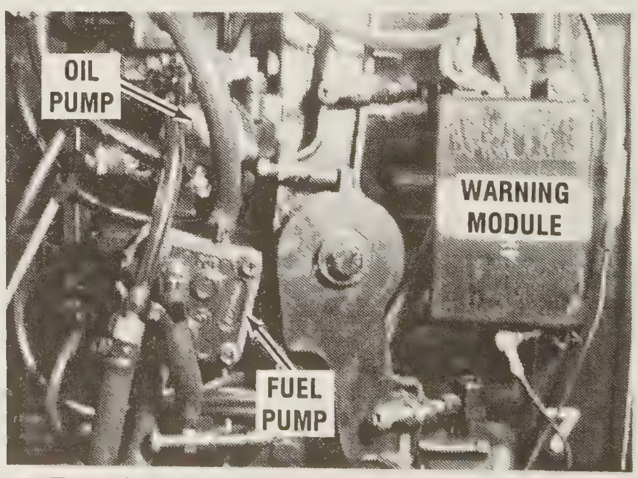
Warning Module

When the ignition key is placed in the **RUN** position, the warning module begins a self test mode. Two different tones are used to warn the operator of a powerhead problem. The first warning tone is a brief steady "Beep" verifying the overheat warning system is functioning. The next tone, is a series of short "Beep - Beep" tones verifying the low oil quantity circuit is functioning properly.

An oil tank gauge kit for the remote oil tank mounted in the boat is available from the Mer-



Typical low oil quantity sending unit in the reservoir mounted on the powerhead.



Typical oil pump, fuel pump, and warning module installed on a V6 powerhead.

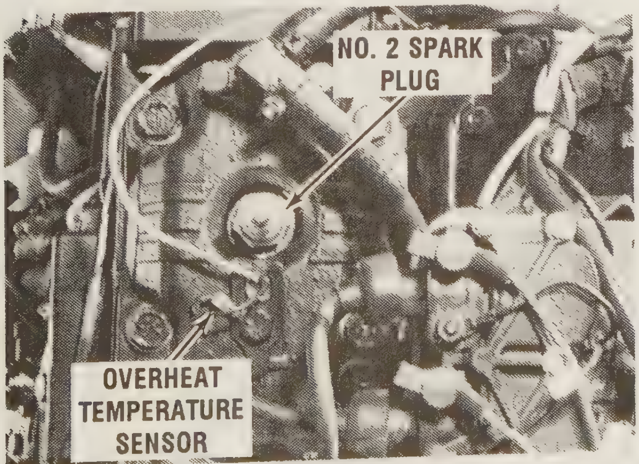
cury/Mariner dealer as an accessory. The kit comes complete with a control panel gauge, remote oil tank sender unit, and necessary wiring. This gauge unit provides the operator a visual indication of oil quantity in the main tank. A complete diagram of the oil quantity sender unit and gauge wiring is located in the Appendix.

Oil Quantity Gauge Operation

The oil quantity gauge operates on the variable resistance to ground principle. A moveable float arm on the sending unit rises and falls as the oil quantity changes. A variable resistor or rheostat is connected to the opposite end of the float arm. When the oil level decreases -- resistance is increased -- allowing less current to flow through the gauge. Since the reduced current passes through the gauge, a bimetal strip in the gauge cools proportionately and moves the needle toward a higher mark on the gauge face. Resistance is lowest when the oil tank is full. As the oil quantity begins to drop, the resistance increases, causing more current to pass through the gauge. The bimetal strip begins to heat-up and moves the needle towards a lower gauge indication.

Oil Quantity Gauge Troubleshooting

Set the key switch to the "**RUN**" position. Disconnect the sensor wire (Light Blue) at the remote oil tank sending unit. Make contact with the sensor wire to a good powerhead ground. The gauge should move towards empty. If the gauge moves - replace the sending unit, if no movement is observed - check for 12- volts DC at the gauge terminal embossed "I" and for a good ground connection at terminal "G". Repair the damaged wire connections or replace the defective oil quantity gauge.



The overheat temperature sensor is mounted in the port cylinder head, just below the No. 2 spark plug.

OVERHEAT TEMPERATURE WARNING

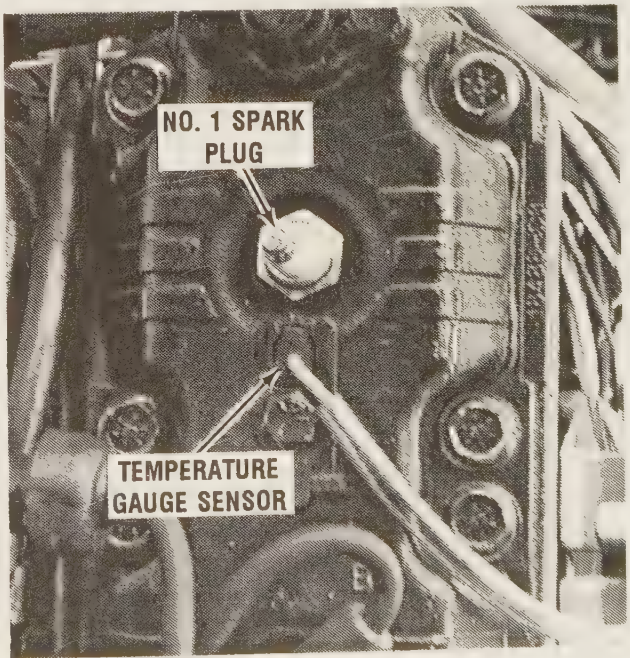
The powerheads covered in this manual are equipped with an Overheat Temperature Sensor mounted in the port cylinder head, just below the No. 2 spark plug. An optional item -- a temperature gauge sending unit may be mounted in the starboard head just below the No. 1 spark plug.

Model 135 thru 200hp and 275hp

If the temperature exceeds approximately 190° F (87°C) the overheat temperature sensor in the water jacket of the cylinder head will close, completing a circuit to the warning module. The warning module will activate the horn in the remote shift box. This warning horn will sound a continuous steady "Beep" tone to warn the operator of the overheat condition.

Model 225hp

The temperature sensor is activated if the powerhead temperature exceeds 200°F (93.3° C). The temperature sensor signal is relayed to the electronic control unit (ECU). If an overheat condition should develop, the ECU will



An optional temperature gauge sending unit may be mounted in the starboard head, below the No.1 spark plug.

perform two functions First, it will activate the warning horn in the remote shift box alerting the operator of the condition. Secondly, it will retard powerhead timing, restricting powerhead speed to a maximum of 3,000 rpm. Once the powerhead temperature drops below 190° F (87°C), the ECU will shut off the warning horn and restore full timing functions for normal powerhead operation.

TEMPERATURE GAUGE

All powerheads covered in this manual are equipped with a standard audible temperature warning system. Many of today's outboards no longer require a temperature gauge for the operator to monitor.

A temperature gauge kit is available from the Mercury/Mariner dealer as an accessory. The kit comes complete with a control panel gauge, temperature sender unit, and necessary wiring. When installed, the gauge unit provides the operator with a visual indication of the powerhead operating temperature. A complete wiring diagram of the temperature gauge system is located in the Appendix.

Temperature Gauge Operation

The temperature gauge must have a 12-volt power and ground wire connected to the gauge. A sensing wire from the gauge should be connected to the temperature sending unit on the powerhead. When the ignition key switch is set to the "**RUN**" position, the bi-metallic resistor in the sending unit has little or no resistance. As the powerhead temperature begins to rise, the resistance increases, causing the needle on the gauge to move. The higher the powerhead temperature -- the more resistance and gauge needle movement.

Gauge Testing

Set the key switch to the "**RUN**" position. Disconnect the sensor wire at the sending unit. Make contact with the sensor wire to a good powerhead ground. If the gauge moves - replace the sending unit, if no movement is observed - check for 12-volts at the gauge unit and the ground connections. Repair damaged wire connections or replace the defective temperature gauge.

WARNING LIGHTS

If a problem arises on a boat equipped with an overheat temperature or low oil quantity light, the first area to check is the light assembly. Check for loose wires or burned-out bulb.

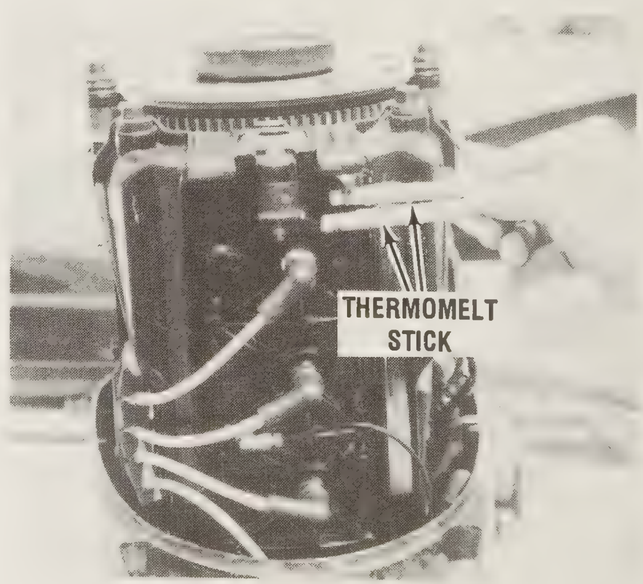
When the ignition key is turned on, the light assembly is supplied with 12 volts and grounded through the sending unit. When the temperature switch makes contact because the water temperature is too high, the circuit to ground is completed and the lamp should light. The low oil quantity light is illuminated when the sending unit in the remote oil tank drops to the low oil quantity level.

Check The Bulb

Set the ignition switch to "**RUN**". Disconnect the Blue or Tan/Blue wire at the sending unit, and make contact with the wire to a good ground. The lamp on the control panel should light with the wire grounded. If the lamp does not light, check for a burned-out bulb or a break in the wiring to the light. If the lamp does light, replace the defective sending unit.

THERMOMELT STICKS

Thermomelt sticks are an easy, inexpensive, and fairly accurate method of determining if the powerhead is operating at the proper temperature.



A thermomelt stick is a quick, simple, inexpensive, and fairly accurate method of determing the operating temperature of the powerhead.

Start and operate the powerhead with the propeller in the water for -- say five minutes -- at about 3000 rpm to allow the powerhead to reach normal operating temperature.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

The 140 degree stick shouild melt when it makes contact with the thermostat housing or on the cylinder head near the No. 1 spark plug. If the stick does not melt, the thermostat is stuck in the open position and powerhead temperature is too low.

Make contact with the 170 degree stick to the same spot on the thermostat housing or the head. The stick should **NOT** melt. If the stick melts, the thermostat is stuck in the closed position and the powerhead is operating too hot.

If the powerhead is not equipped with a thermostat, the problem may be solved by reverse flushing to clean out the cooling system and/or servicing the water pump. For thermostat service procedures -- see Chapter 8. For water pump service -- see Chapter 9.

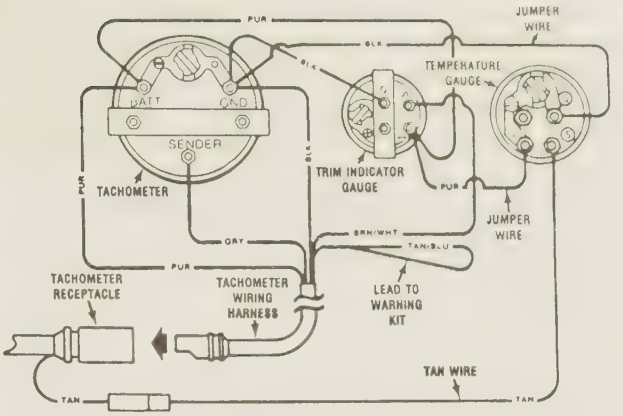
7-4 TACHOMETER

An accurate **OUTBOARD TWO-STROKE MARINE** tachometer can be installed on any powerhead, but it **MUST** be an outboard two-stroke unit. Such an instrument provides an indication of powerhead speed in revolutions per minute -- commonly abbreviated simply "rpm". This is accomplished by measuring the number of electrical pulses per minute generated in the primary circuit of the ignition system.

The meter readings range from 0 to 8,000 rpm, in increments of 100. Tachometers have solid-state electronic circuits which eliminates the need for relays or batteries and contributes to their accuracy. The electronic parts of the tachometer, susceptible to moisture, are coated to prolong their life.

SPECIAL WORDS ON TACHOMETERS AND CONNECTIONS

Theoretically, it should be possible to connect a tachometer to any engine and receive an

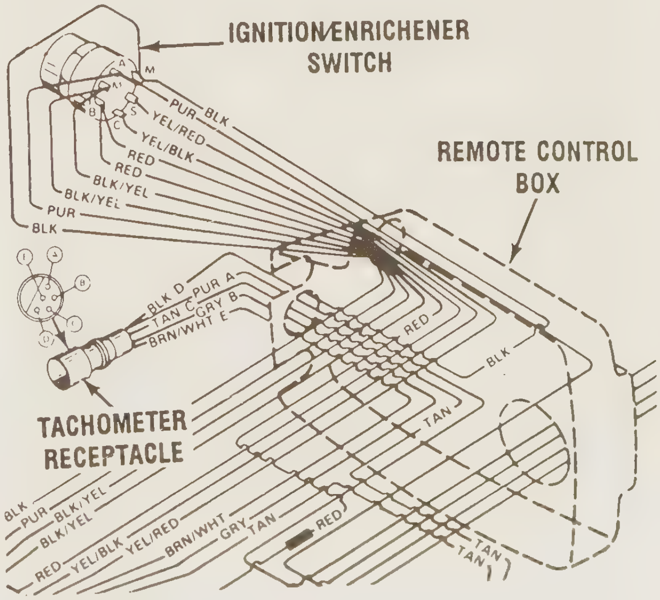


Wiring diagram for a typical tachometer installation on the V6 powerheads covered in this manual.

accurate count of crankshaft rotation -- **RIGHT? WRONG!** Unfortunately, this is not the case. Tachometer manufacturers admit, on certain two-stroke applications where points, and an ignition coil are **NOT** used, an attempt to connect a tachometer to the unit would "go up in smoke".

The general rules for connecting a tachometer to a marine two-stroke powerhead are as follows:

1- The tachometer **MUST** be calibrated at the factory for two-stroke applications. Some tachometers have a dial indicator which may simply be switched from two-stroke to four-stroke and back again. Other tachometers have a digital readout indicating the rpm.



Tachometer receptacle on the forward face of the remote control box. Wire color code identified.

2- A tachometer may have as many as **FOUR** leads. The meter will always have a minimum of an input lead and a ground lead. The colors of these leads may vary between manufacturers, but the instructions provided with the meter will (or should), identify these leads. The meter input lead is connected to the Gray wire lead coming from the voltage regulator. The ground lead is connected to a suitable ground on the powerhead or control panel.

3- On most larger horsepower powerheads, the tachometer connection is quite simple. The tachometer input lead is connected to the input lead on the powerhead terminal block, as shown in the accompanying illustration.

4- Some tachometers have a third lead which is considered a "hot" lead. This "hot" lead is connected to the **POSITIVE** battery terminal.

On other tachometers, this "hot" lead is only used for an internal light bulb to illuminate the meter face. On still other tachometers this "hot" lead is necessary to the operation of the meter.

ONCE AGAIN, the instructions with the tachometer should identify the "hot" lead. A fourth lead from the tachometer is used as the ground lead to the light bulb.

FIRST, last, and **ALWAYS**, check the tachometer manufacturer's instructions for use with a two-stroke unit.

LAST WORDS

Most outboard units covered in this manual have a female plug at the forward end of the shift box as a convenience for installation of a tachometer. Therefore, when purchasing a tachometer, check to be sure the adaptor plug will mate with the fitting on the shift box.

7-5 TILT STOP SWITCH

The tilt stop switch is a mercury switch mounted on the starboard side of the powerhead next to the switch box. The switch is connected to the ignition circuit and serves a dual purpose.

The primary function is to shut down the powerhead if an underwater object is struck during boat movement causing the lower unit to kick up and out of the water. The propeller would no longer be loaded down and the powerhead could "runaway" -- due to the no load condition -- causing severe mechanical damage to the powerhead. The second function of the switch is to prevent the powerhead from being started while the outboard unit is in the upper tilt position.

When the powerhead is tilted **UP** past approximately a 45° tilt angle, the mercury inside the switch makes contact and grounds out the ignition system.

Therefore, when troubleshooting the ignition system, the mercury switch **MUST** be disconnected, otherwise the symptom and indications will indicate a faulty switch box.

If the mercury tilt stop switch is suspected of being defective a simple test with an Ohmmeter can validate the usability of the switch.

Mercury Tilt Stop Switch Test

a- Disconnect and remove the mercury tilt stop switch from the powerhead.

b- Set an Ohmmeter to the Rx1 scale and connect the Black meter lead to the Black wire and the Red meter lead to the Black/Yellow wire of the switch.

c- Position the mercury switch as it would be with the powerhead in the **"DOWN"** position. The meter should indicate no continuity. If the meter indicates continuity, replace the mercury switch.

d- Rotate the mercury switch as it would be positioned with the powerhead in the **"UP"** position. The meter should indicate no continuity.

If the meter indicates continuity, replace the mercury switch.

7-6 HORNS

The only reason for servicing a horn is because it fails to operate properly or because it is out of tune. In most cases, the problem can be traced to an open circuit in the wiring or to a defective relay.

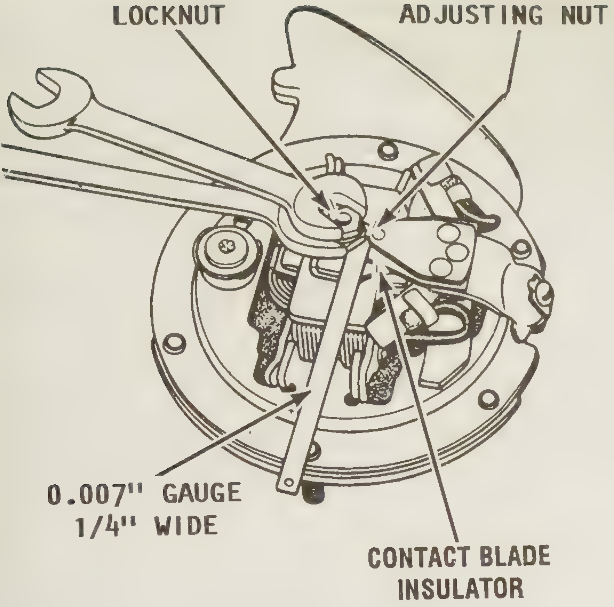
Cleaning

Crocus cloth and carbon tetrachloride should be used to clean the contact points. **NEVER** force the contacts apart or the contact spring will be bent and change the operating tension.

Check Relay and Wiring

Connect a wire from the battery to the horn terminal. If the horn operates, the problem is in the relay or in the horn wiring. If both of these appear satisfactory, the horn is defective and needs to be replaced.

However, before replacing the horn, connect a second jumper wire from the horn frame to ground to check the ground connection.



*The tone of a horn can be adjusted with a 0.007" feeler gauge, as described in the text. **TAKE CARE** to prevent the feeler gauge from making contact with the case, or the circuit will be shorted out.*

Test the winding for an open circuit, faulty insulation, or poor ground. Check the resistor with an ohmmeter, or test the condenser for capacity, ground, and leakage. Inspect the diaphragm for cracks.

Adjust Horn Tone

Loosen the locknut, and then rotate the adjusting screw until the desired tone is reached. On a dual horn installation, disconnect one horn and adjust each, one-at-a-time. The contact point adjustment is made by inserting a 0.007" (0.18mm) feeler gauge blade between the adjusting nut and the contact blade insulator. **TAKE CARE** not to allow the feeler gauge to make contact with the metallic parts of the contact points, because such action would short them out. Now, loosen the locknut and turn the adjusting nut down until the horn fails to sound. Loosen the adjusting nut slowly until the horn barely sounds. The locknut **MUST** be tightened after each test. When the feeler gauge is withdrawn the horn will operate properly and the current draw will be satisfactory.

7-7 ELECTRICAL SYSTEM GENERAL INFORMATION

In the early days, all outboard units were started by simply pulling on a rope wound around the flywheel. As the manufacturers increased the size and horsepower, especially after the introduction of multi-cylinder high-compression units, it was necessary to replace the rope starter with some form of power cranking. Today, most small powerheads are still cranked by pulling a rope.

The system utilized to replace the rope method of cranking for larger powerheads was an electric cranking motor coupled with a mechanical gear mesh between the cranking motor and the powerhead flywheel, similar to the method used to crank an automobile engine.

Since the cranking motor requires a large amount of electrical current, it is necessary to have a fully charged battery available for the cranking system. The battery can be externally charged or the powerhead can be equipped with an alternator to charge the battery while the powerhead is operating.

After the battery became a standard addition to the larger powerheads, the next logical improvement was to improve the ignition system. Since the mid 1960's the trend has been to replace the conventional ignition system with a capacitor-discharge (**CD**) type system, using a solid-state triggering module (switch box). With this system, a pulse generator replaces the conventional breaker points.

The electrical system for the powerheads covered in this manual now consists of four circuits:

a- Charging circuit
b- Cranking motor circuit
c- Enrichener circuit
d- Ignition circuit

Charging Circuit

There are two types of alternators used for the charging circuit on the powerheads covered in this manual. The flywheel stator alternator is mounted under the flywheel and uses magnets mounted on the outside rim of the flywheel for field excitation. The second alternator is a complete individual unit which is belt driven from the flywheel, similar to the type used on modern automobiles.

Flywheel Stator Alternator

This charging circuit consists of permanent magnets mounted in the flywheel; a series of charging coils or stator located under the flywheel; and a single voltage regulator mounted on the powerhead under the electrical access cover. Some units have dual voltage regulators located on the rear of the powerhead between

the cylinder heads. An external 12-volt marine battery; and the necessary wiring to connect it all together for efficient operation completes the list of components for the system.

Most V6 powerheads prior to 1993 with a 16-ampere charging circuit use a rectifier/voltage regulator circuit. Units with the 40-ampere alternator charging circuit utilize a large finned single voltage regulator. Primarily, both systems operate on the same principle. The alternating current generated in the stator windings pass to the rectifier/regulator. The rectifier/regulator changes the alternating current (AC) to direct current (DC) for charging the 12-volt battery.

After 1993 almost all V6 powerheads have a standard 40-ampere alternator with dual voltage regulators. The dual voltage regulators are much smaller in size and have been redesigned, eliminating the need for large heat sink cooling fins. Because the two regulators are connected in a parallel circuit, they can handle electrical load demands more effectively with less power loss. The charging circuit operates in much the same manner as described in previous paragraph for units prior to 1993. One major difference with the dual voltage regulators is their ability to control output of the 40- ampere alternator coils and improve reliability.

Belt Driven Alternator

This charging circuit is found only on the Model 225hp powerheads. The alternator is a complete, self contained unit similar to the type used in the automotive industry. As the name implies, this alternator is mechanically driven by a V-belt from the flywheel to an alternator pulley. The rectifier and voltage regulator are replaceable modules attached to one end of the frame rotor assembly.

Replacement of these modules is a simple task and does not require complete alternator disassembly. The alternator has a rated output of 60 amperes, at 2200 rpm. Voltage is regulated between 13.5 to 15.1 volts DC. The alternator is connected to the powerhead circuit with a two wire plug-in connector and one terminal connection.

Some precautions **MUST** be observed when servicing this type charging circuit to prevent serious damage to the alternator and/or circuit wiring:

a. NEVER attempt to polarize the alternator. Such action would destroy the rectifier assembly.

b. Do **NOT** short across or ground any terminals on the alternator -- except when specifically instructed to do so in the testing procedures.

c. NEVER disconnect electrical leads to the alternator or battery while the powerhead is operating and the alternator is being driven by the flywheel.

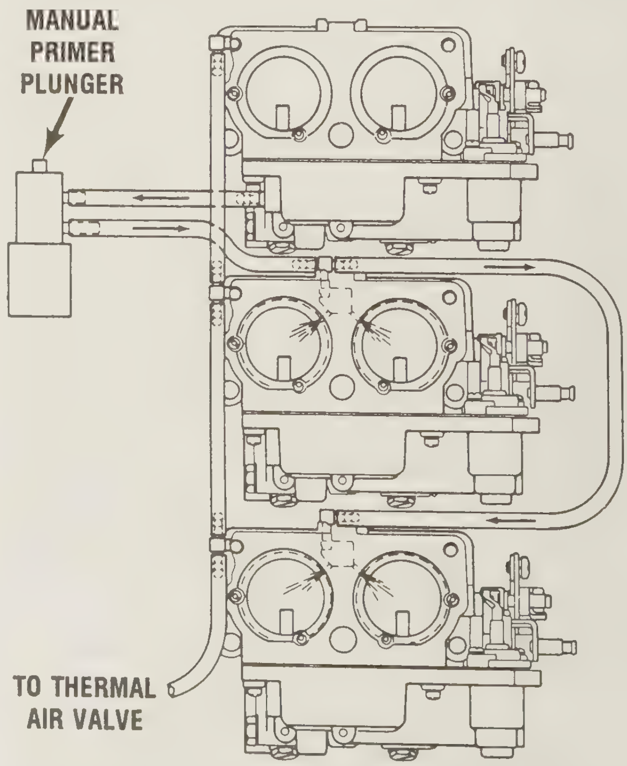
d. BEFORE working on the alternator and charging circuit wiring, **ALWAYS** disconnect the negative (-) battery cable.

e. ALWAYS connect the negative (-) cable to the negative battery terminal **FIRST**, and then connect the positive (+) cable to the positive battery terminal, when installing a battery.

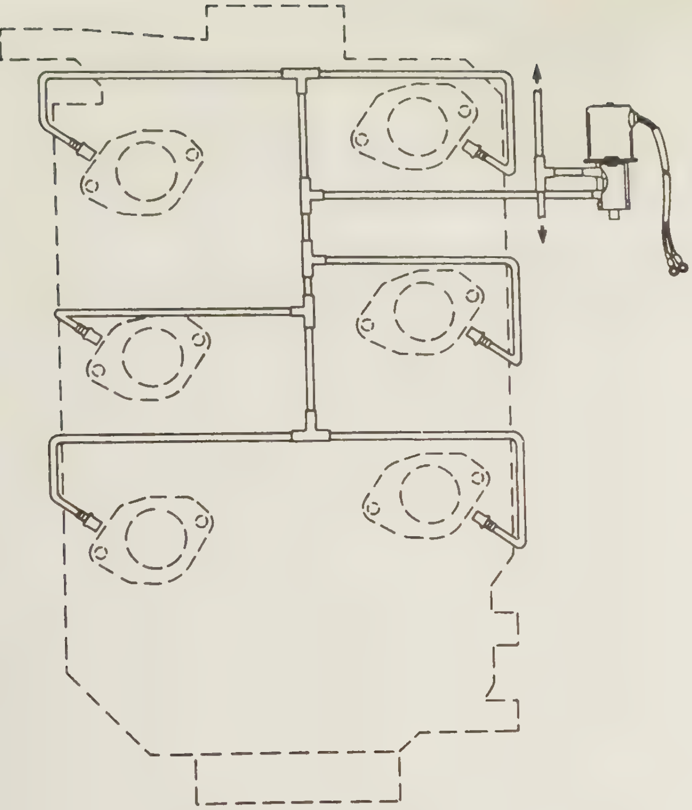
Enrichener Circuit

The enrichener system provides for easier starting of a cold powerhead. The enrichener valve is electrically activated by turning the key switch to the **START** position; pushing the key switch inward and holding it in this position. The enrichener valve opens and primes the powerhead with fuel through the carburetor mounting flange or directly into the cylinder, depending on model powerhead. When the key is released, the valve will automatically close.

The enrichener valve may also be operated manually by depressing the manual primer button located on the valve.



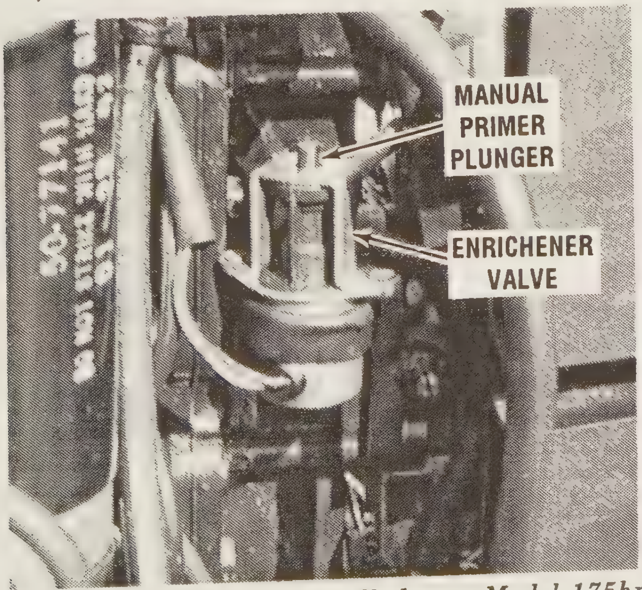
Simple line drawing of the enrichener valve arrangement on the Model 135 thru 225hp V6 powerhead.



Another simple line drawing to depict the enrichener valve arrangement on the Model 275hp powerhead.

Cranking Motor Circuit

The cranking motor circuit consists of a cranking motor; a heavy duty solenoid switch to carry the heavy current loads from the battery; a neutral start switch to prevent the powerhead start-up while the outboard is in gear; and a key switch. On all electric start models, the cranking motor solenoid is actuated by turning the key switch to the **START** position.



Enrichener valve installed on a Model 175hp powerhead. The manual plunger is clearly visible.

CHARGING CIRCUIT SERVICE

Models 135 thru 200hp and 275hp

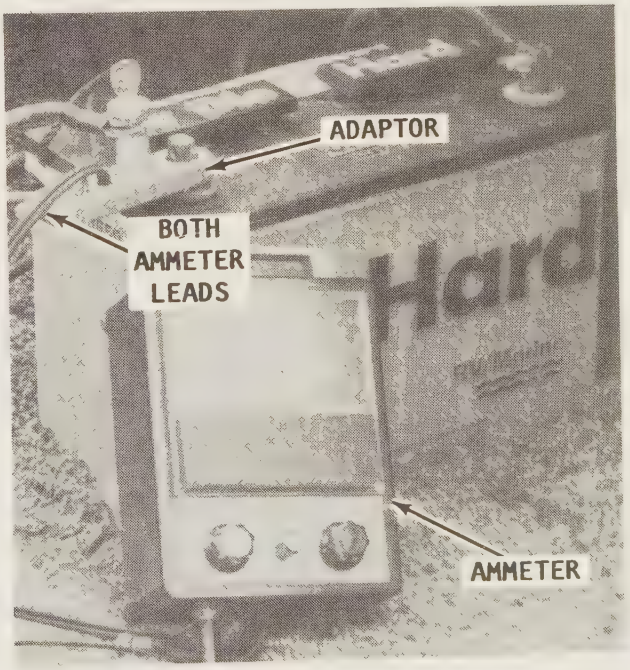
(See Page 7-22 for Model 225hp)

The stator is located under, and protected by, the flywheel. Therefore, the stator seldom causes problems in the charging circuit. Most problems in the charging circuit can be traced to loose or damaged wiring, defective rectifier/ voltage regulator or a defective battery. If the stator, rectifier, voltage regulator or battery fails the troubleshooting test, these defective components cannot be repaired, and **MUST** be replaced.

TROUBLESHOOTING

When a component in the battery charging circuit becomes defective, the battery usually shows the first symptom -- undercharged or dead. In most cases, a full charge to the battery and a check of the electrolyte will bring it back to full life. An electrolyte level check is explained in Section 7-2 of this chapter.

If the battery will not accept a charge, the battery **MUST** be replaced. If the battery does accept a full charge, steps should be taken to determine what caused the battery to discharge. A quick visual inspection of the powerhead and other components listed below will eliminate some of the most common causes.



*To test the output amperage of the battery, without creating excessive sparking, an ammeter **MUST** be connected to the cranking circuit in series with the powerhead load through an adaptor.*

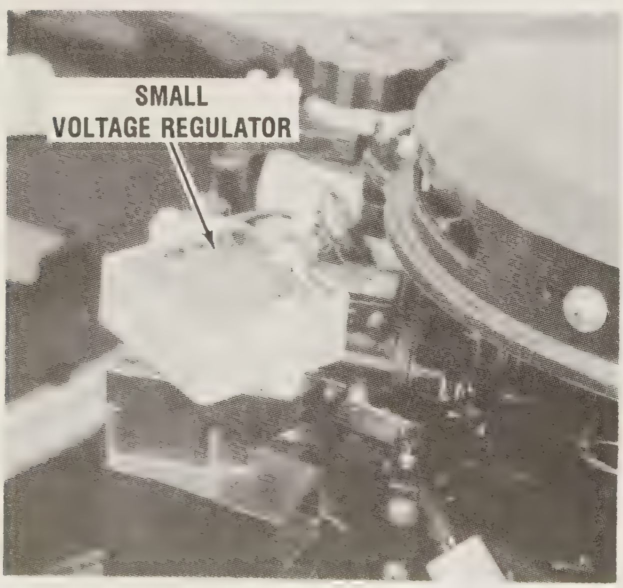
a- Check the battery cables and terminal ends for corrosion. Clean the cable and terminal ends free of all corrosion. Apply a clear corrosion inhibitor over the terminal ends or a thin film of water proof grease to prevent corrosion build-up again.

b- Check the polarity and color markings - Red (+) for the positive side and Black (−) for the negative battery cable. If the battery cables were connected in reverse polarity, perform the "Rectifier Test" in this section, because the rectifier was most likely damaged from incorrect polarity.

c- Visually inspect the wiring from the stator coil to the battery for cuts, chafing, loose or disconnected terminals, and corroded connections. Repair any defects found in the wiring.

d- Ask the question: "Have any new accessories been added to the craft recently - depth or fish finders, live bait tanks or any other item." If the answer is "yes", possibly the combined amperage draw from all or one accessory item may now exceed the amperage output of the alternator. If such is the case, then contact a local marine dealer for advice and installation of a larger alternator and/or battery combination. There is no way on these blue/green waters -- all such added "toys" can be powered with a flashlight battery.

If the visual inspection determines the battery connections and wiring are all in satisfactory condition, then perform one of the following alternator output tests for the size alternator on the powerhead.



Location of a small voltage regulator described in the text.

VOLTAGE REGULATOR TESTING

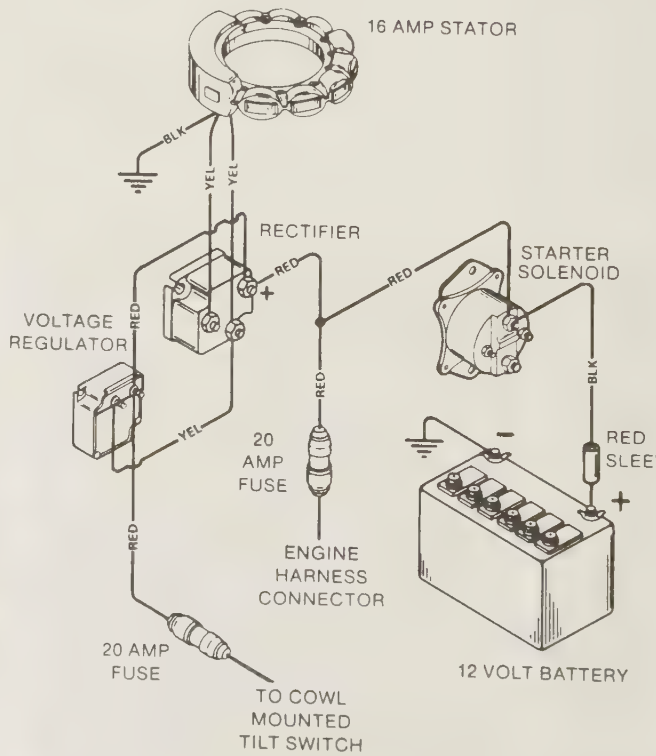
The alternator output and the voltage regulator/rectifier are tested simultaneously during the same test.

16 Amp Alternator Output Test with Rectifier and Voltage Regulator

a- Disconnect the Yellow wire lead from the regulator terminal. Temporarily insulate the wire terminal with tape and secure the lead to the wire harness.

b- Connect the Red (+) volt meter lead to the positive (+) battery terminal and the Black (-) meter lead to the negative (-) battery terminal.

c- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller causing severe and expensive damage.



Functional diagram of a typical 16-amp charging system. Notice this system has a voltage regulator and a rectifier.

CAUTION

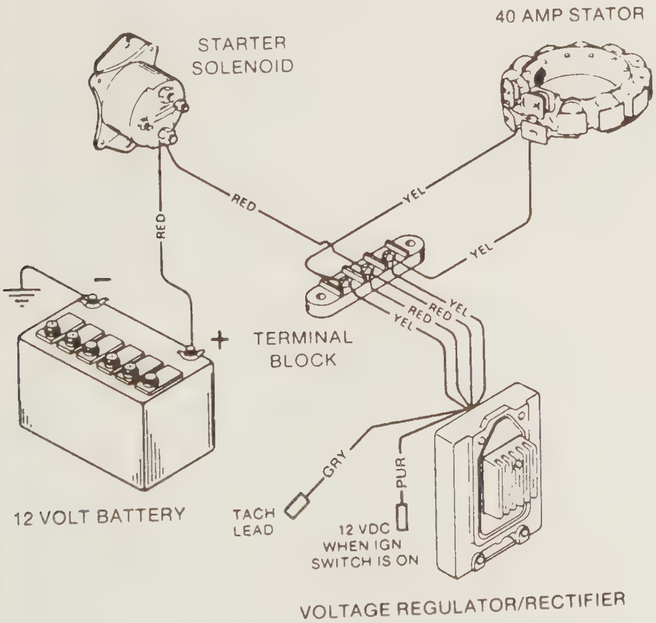
Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

d- Start the powerhead and slowly advance the throttle to 1500 rpm. The meter should indicate battery voltage gradually rising, **BUT NOT** above 14-volts. If battery voltage rises above 14-volts, the regulator/rectifier is defective and **MUST** be replaced. If the battery voltage does not increase to about 14-volts, then either the stator or the regulator/rectifier is defective.

e- Perform the Stator Alternator Coil Ohms test procedures in this section on the stator coil. If the stator coil is found to be defective then it **MUST** be replaced. If the stator coil check is satisfactory, perform the Rectifier Troubleshooting Test procedures on the rectifier. If the rectifier is found to be defective then it **MUST** be replaced.

40-Amp Alternator Output Test with Large Voltage Regulator

Prior to performing this test, check all charging circuit wiring from the powerhead to the battery. Look for loose terminals, loose bullet connectors, and loose or corroded hardware securing the voltage regulator to the powerhead. Check the battery cables for broken insulation and corrosion. Verify the battery posts are clean and the cables are in good serviceable condition. Batteries should have a full charge and **MUST NOT** be connected to any other charging device.



Functional diagram of a 40-amp charging system. Notice, this system has one large regulator/rectifier.

a- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

b- Obtain a VOA meter. Connect the Red meter lead to the positive (+) battery terminal. and the Black negative (-) meter lead to the negative battery terminal. Observe the meter reading and note this as "battery voltage".

c- Crank the powerhead with the cranking motor while monitoring the meter. If the battery voltage drops below 9.5 volts while cranking the powerhead, the battery is weak and should be checked for a defective cell(s) and fully recharged or replaced.

d- If the cranking voltage is acceptable, start and operate the powerhead at 1,000 rpm. Observe the meter reading. Battery voltage should rise to approximately 14.5 volts and then stabilize.

If the voltage does **NOT** increase above the previously indicated "battery voltage", shut down the powerhead and continue the troubleshooting procedures at "Charging Circuit Has No Output" in this section.

If the "battery voltage" exceeds 16.0 volts, and/or does not return to approximately 14.5 volts, continue the troubleshooting procedures at Charging Circuit Has Constant High Output, in this section.

Charging Circuit Has No Output

a- Obtain a VOA meter. Connect the positive (+) meter lead to the Purple wire lead (bullet connector) at the voltage regulator. Do not disconnect the bullet connector. Connect the Black negative (-) meter lead to a good powerhead ground.

b- Place the key switch in **RUN** position. The meter should indicate "battery voltage". If battery voltage is **NOT** present, troubleshoot for broken or damaged wiring from the key switch to the main powerhead harness.

c- Set the meter switches for AC voltage readings. Connect the Red positive (+) meter lead to one of the voltage regulator Yellow leads on the terminal block and the Black (-) negative meter lead to the other voltage regulator Yellow lead on the terminal block. Tape and secure any loose wires clear of the flywheel.

d- Start and operate the powerhead at approximately 1,000 rpm. If the voltage is greater than 16 VAC, the regulator is defective. Perform the Voltage Regulator Static Ohms Test to verify the regulator is defective and **MUST** be replaced. If the AC voltage is zero or some value lower than "battery voltage", perform the Stator Alternator Coil Test, in this section.

Charging Circuit
Has High Output

a- Remove the flywheel from the powerhead, as described in Chapter 8 -- Powerhead. Visually inspect the stator alternator coils for signs of discoloration, burned or broken wires. If there is any obvious damage to the stator coils, the unit **MUST** be replaced. If there is no damage to the stator coils or wiring, install the flywheel as described in Chapter 8.

b- Set the VOA meter for Amperes reading. The meter should be capable of carrying up to 40 amps. Disconnect the Red wire lead from terminal block above the voltage regulator. Connect the Red meter test lead to the terminal block where the Red wire was previously disconnected. Connect the Black meter test lead to the loose Red wire to the starter solenoid.

c- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

d- Disconnect one Yellow stator lead from the terminal block. Tape and secure any loose wires clear of the flywheel. Start and operate the powerhead between 1000 - 2000 rpm. Observe the meter for current output. If no current output is observed, shutdown the powerhead, connect the loose Yellow stator lead.

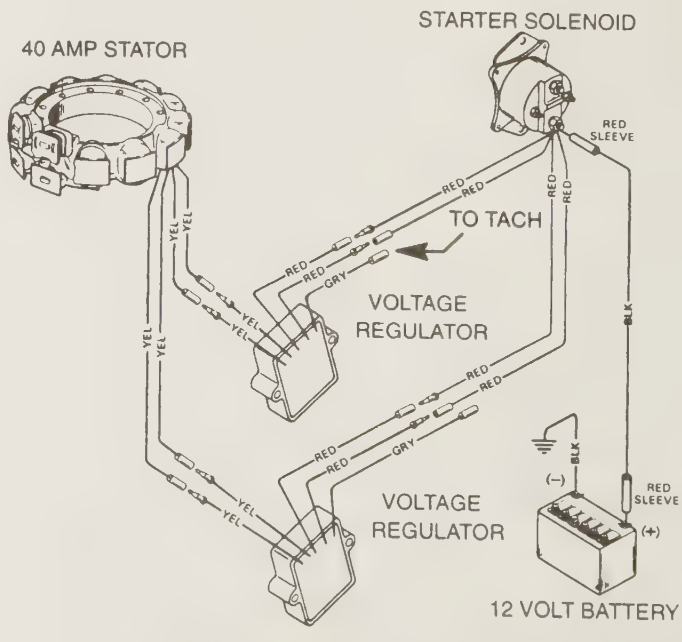
Now, disconnect the opposite Yellow stator lead from the terminal block. Start and operate the powerhead between 1000 - 2000 rpm. Observe the meter for current output.

If current output is observed during the test, the stator is shorted to ground and **MUST** be replaced. If there was **NO** output during this test with either Yellow leads from the stator disconnected, the voltage regulator is defective and **MUST** be replaced.

REGULATOR WORDS

The signal for the tachometer originates in the voltage regulator. Therefore, it is possible to have an accurate signal to the tachometer, but the regulator itself may still be defective.

The voltage regulator is mounted directly to the powerhead casting under the trim and tilt relay panel. If the powerhead is not receiving sufficient cooling water due to a damaged water pump or blocked passage, a thermal overload protection device -- heat sensitive -- inside the regulator is designed to stop current flow to the battery, thereby protecting the voltage regulator from overheating. Therefore, it is possible



Functional diagram of a 40-amp charging system with two voltage regulators.

to have a normal charging circuit when the powerhead is cold, but a defective charging circuit when the powerhead heats to or beyond normal operating temperature.

Regulator Voltage Check

a- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

b- Obtain a VOA meter. Connect the positive Red (+) meter lead to the positive terminal on the battery. Connect the Black (-) negative meter lead to the negative battery terminal.

c- Turn all the electrical accessories on the boat to **ON**. Crank the powerhead with the cranking motor for approximately 20 seconds with the lanyard switch turned **OFF**, or the emergency stop switch set **ON** to prevent the powerhead from starting. This cranking will drain some of the charge from the battery.

d- Observe the meter reading and note this as "battery voltage". Start and operate the powerhead at 1,000 rpm. Observe the meter reading. Battery voltage should rise to approximately 14.5 volts and then stabilize.

If the voltage did **NOT** increase to about 14.5 volts and stabilize, shut down the powerhead and continue the troubleshooting procedures at Charging Circuit Has No Output.

If the "battery voltage" increases to 16.0 volts, and/or does not return to approximately 14.5 volts, shut down the powerhead and continue the troubleshooting procedures at Charging Circuit Has Constant High Output.

40 Amp Alternator With Dual Voltage Regulators Output Test

Prior to performing this test, check all charging circuit wiring from the powerhead to the battery. Look for loose terminals, loose bullet connectors, and loose or corroded hardware securing the voltage regulator to the powerhead. Check the battery cables for broken insulation and corrosion. Check to be sure the battery posts are clean and the cables are in good serviceable condition. Batteries should have a full charge and **MUST NOT** be connected to any other charging device.

a- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

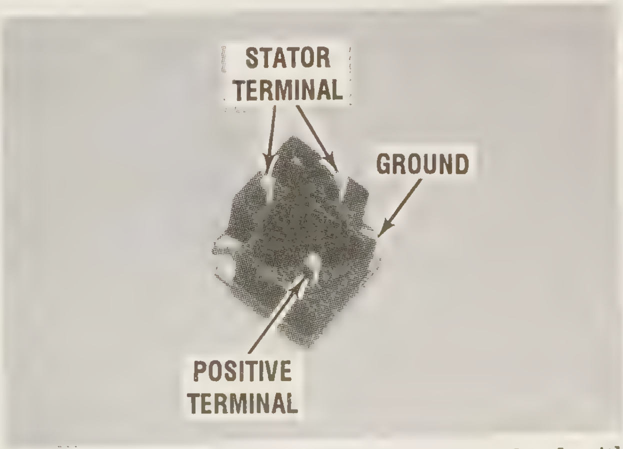
CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

b- Obtain a VOA meter. Connect the Red positive (+) meter lead to the positive battery terminal. Connect the Black negative (-) meter lead to the negative battery terminal. Observe the meter reading and note this as "battery voltage".

c- Crank the powerhead with the cranking motor, and at the same time monitor the meter. If the battery voltage drops below 9.5 volts while cranking the powerhead, the battery is weak and should be fully charged, checked for defective cell(s) or replaced.

d- If the cranking voltage is acceptable, start and operate the powerhead at 1,000 rpm. Observe the meter reading. Battery voltage



Up-to-date rectifier installed on the powerhead, with the terminals identified for test purposes.

should rise to approximately 14.5 volts and then stabilize.

If the voltage did **NOT** increase above indicated "battery voltage", shut down the powerhead and continue the troubleshooting procedures at Charging Circuit Has No Output - Dual Regulators.

If the "battery voltage" increases to 16.0 volts, and/or does not return to approximately 14.5 volts, continue the troubleshooting procedures at Charging Circuit Has Constant High Output - Dual Regulators.

Charging Circuit Has No Output - Dual Regulators.

a- Obtain a VOA meter. Connect the Red positive (+) meter lead to either Red wires (bullet connector) to the voltage regulators. Do not disconnect the bullet connector. Connect the Black negative (-) meter lead to a good powerhead ground.

b- Place the key switch in the **RUN** position. The meter should indicate "battery voltage". If battery voltage is **NOT** present, troubleshoot for broken or damaged wiring from the key switch to the main powerhead harness.

c- Set the VOA meter switches for AC voltage readings. Connect the meter leads to either the two short Yellow wire leads, or the two long Yellow wire leads from the stator to the voltage regulator. Tape and secure any loose wires clear of the flywheel.

d- Start and operate the powerhead at approximately 1,000 rpm. If the voltage is greater than 16 VAC, the regulator is defective and **MUST** be replaced. If the AC voltage is zero or lower than "battery voltage", perform the Stator Alternator Coils Test, in this section.

Charging Circuit Has Constant High Output - Dual Voltage Regulators.

a- Remove the flywheel from the powerhead as described in Chapter 8 -- Powerhead. Visually inspect the stator alternator coils for signs of discoloration, burned or broken wires. If there is any obvious damage to the stator coils, the unit **MUST** be replaced. If there is no damage to the stator coils or wiring, install the flywheel -- Chapter 8.

b- Set the VOA meter for Amperes reading. The meter should be capable of carrying up to 40-amps. Disconnect the Red wire lead from the terminal block above the voltage regulator. Connect the Red meter lead to the terminal block where the Red wire was disconnected. Connect the Black meter lead to the loose Red wire to the starter solenoid.

c- Secure any loose wires on the powerhead clear of the flywheel. Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

CAUTION

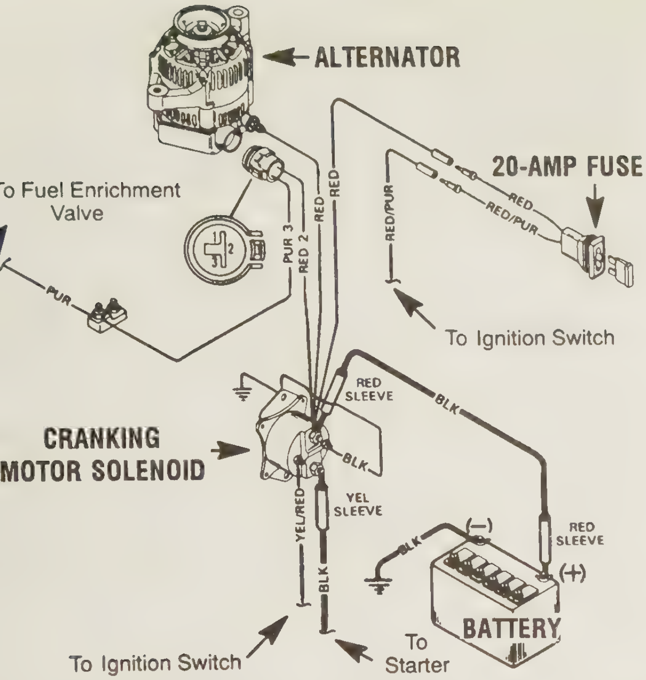
Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

d- Disconnect one short and two long Yellow stator leads from the bullet connectors. Tape and secure any loose wires clear of the flywheel. Start and operate the powerhead between 1000 and 2000 rpm while observing the meter for current output. If there is no current output observed, shutdown the powerhead, reconnect the one short and two long Yellow stator leads, previously disconnected. Now, disconnect the two short and the opposite one long Yellow stator leads. Tape and secure any loose wires clear of the flywheel. Start and operate the powerhead between 1000 and 2000 rpm. Observe the meter for current output.

If output current was observed during this test, the stator is shorted to ground and **MUST** be replaced. If there was **NO** current output indicated during this test with either short or long Yellow leads to the stator disconnected, the voltage regulators are defective. Perform the Voltage Regulator Ohms Test to verify the regulator is defective and **MUST** be replaced.

Charging Circuit Service
60-Ampere Belt Driven Alternator
Model 225hp Only

The Model 225hp powerhead has an external mounted alternator. Unlike the previous models with the alternator stator mounted under the flywheel, this unit requires the use of a drive belt from the flywheel to a pulley on the alternator for power. The 60-ampere alternator housing contains both a diode rectifier and a voltage regulator. Therefore, if troubleshooting and testing recommends either of these



Functional diagram of a 60-amp alternator charging system. The letters are referenced in the test procedures.

items be replaced, the alternator assembly **MUST** be removed from the powerhead to gain access.

60-Ampere Alternator Testing

Prior to performing this test, check all charging circuit wiring from the powerhead to the battery. Look for loose terminals and loose bullet connectors, and loose or corroded hardware securing the alternator to the powerhead. Check the battery cables for broken insulation and corrosion. Check to be sure the battery posts are clean and the cables are in good serviceable condition. Batteries should have a full charge and **MUST NOT** be connected to any other charging device. Check the condition of the alternator drive belt for proper tension If the belt can be deflected with thumb pressure more than 1/2", adjust the belt tension per the instructions given in the Belt Tension Adjustment in this section. Look for signs of the belt cracking or fraying. If any of these conditions are found, the belt **MUST** be replaced.

Charging Circuit Wiring Test

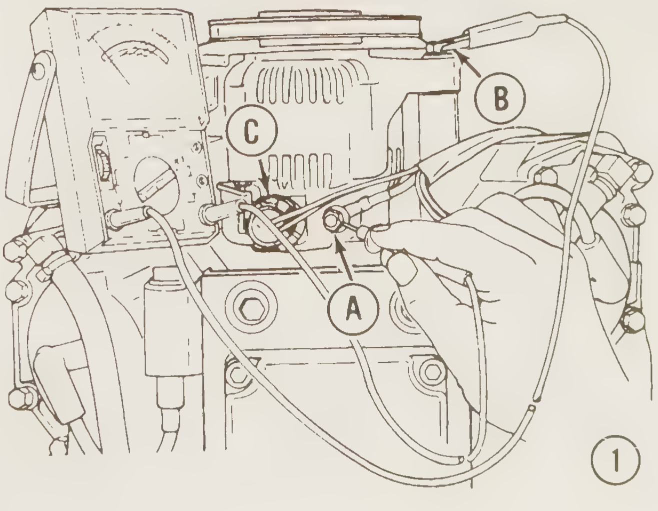
a- Use the accompanying illustration numbered "1" in the next column with this procedure. The lettered test points refer to the letters on the illustration. Obtain a VOA meter. Set the meter for the 0-20 VDC scale reading. Connect the Red positive (+) meter lead to the alternator output terminal (A). Connect the Black meter lead to ground (B). The meter should indicate battery voltage of 12 to 14.5 VDC. Shake the wiring harness and observe the meter for any sign of voltage fluctuation. If the meter fails to indicate battery voltage, check for broken or damaged wiring from the starter solenoid to the alternator terminal (A).

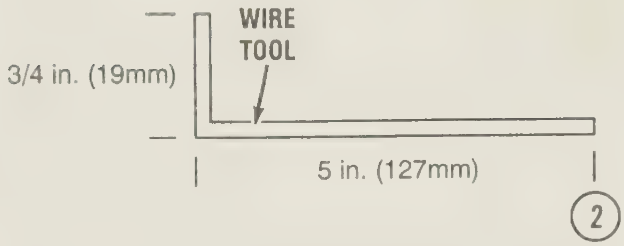
b- Use the accompanying illustration identified as a circled "1" for this test. Unplug the sensing wire circuit plug (C) from the alternator case. Connect the Red positive (+) meter lead to the Red wire terminal on the connector plug (C). Connect the Black meter lead to ground (B). Set the ignition switch to the **RUN** position. The meter should indicate battery voltage between 12 - 14.5 VDC. If meter fails to indicate battery voltage, check for broken or damaged wiring from the starter solenoid to the sensing plug.

c- Move the Red positive (+) meter lead to the Purple wire terminal on the connector plug (C). Set the ignition switch to the **RUN** position. The meter should indicate battery voltage between 12 and 14.5 VDC. If meter fails to indicate battery voltage, check for broken or damaged wiring from the connector plug to the terminal block on the powerhead. Check the Purple wire from the terminal block to the ECU connector plug.

Voltage Output Test

a- Continue to use illustration numbered "1". Connect the Red positive (+) meter lead to the output terminal (A) on the alternator. Connect the Black meter lead to ground (B).



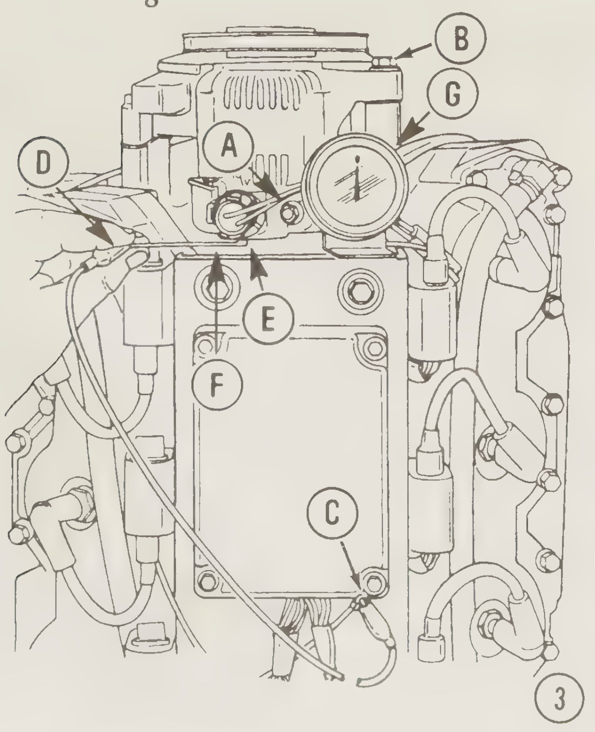


b- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

c- Start the powerhead and allow it to warm to normal operating temperature. Advance the throttle from idle position to 2000 rpm. Observe the VOA meter. Voltage output should be between 13.5 to 15.1 VDC. If the voltage is greater than 15.1 VDC, the regulator on the alternator is defective and **MUST** be replaced. If the voltage is less than 13.5 VDC, perform the following test.



d- Use the illustration numbered "2" for this step. Obtain a piece of solid copper wire (#14 gauge Romex or THNN wire). Bend the wire to the dimension given in the accompanying illustration and strip approximately 1/2" inch of insulation from both ends. This wire will now be used as a "tool".

e- Use illustration numbered "3" for this step. Insert the 90° end of the wire tool (F) into terminal (E) on the back of the alternator. Attach a jumper wire (D) from the end of the wire tool to ground (C). Obtain a VOA meter. Connect the Red (positive (+) meter lead to the output terminal (A). Connect the Black negative (-) meter lead to ground (B). Start the powerhead and allow it to warm to operating temperature.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Advance the throttle from idle to 2000 rpm. If the voltage rises within the normal range 13.5 to 15.1VDC, the voltage regulator is defective and **MUST** be replaced. If the voltage does **NOT** rise to the normal range, perform the following Current Output Test.

Current Output Test

a- Continue to use illustration numbered "3" for this test. Connect an ammeter gauge (G) in series between output terminal (A) on the alternator and the starter solenoid terminal. The ammeter **MUST** be capable of indicating up to 60 amps.

b- Place the outboard in a test tank or move the boat to a body of water. If this is not possible, connect a flush attachment and garden hose to the lower unit. If a flush attachment is used, **DO NOT** operate the powerhead at a high rpm. Such action could cause the powerhead to **RUNAWAY** from the no load on the propeller, causing severe and expensive damage.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.

Start the powerhead and allow it to warm to normal operating temperature.

c- Insert the wire tool (F) into terminal (E) on the alternator. Connect a jumper wire (D) from the wire tool to ground (C). Advance the throttle from idle to 2000 rpm and observe the ammeter (G). Normal output should be 60 amperes @ 2000 rpm. If the current output is normal, the voltage regulator is defective and **MUST** be replaced. If the current output is low, the alternator is defective and **MUST** be replaced.

ALTERNATOR WORDS

Model 225hp Only

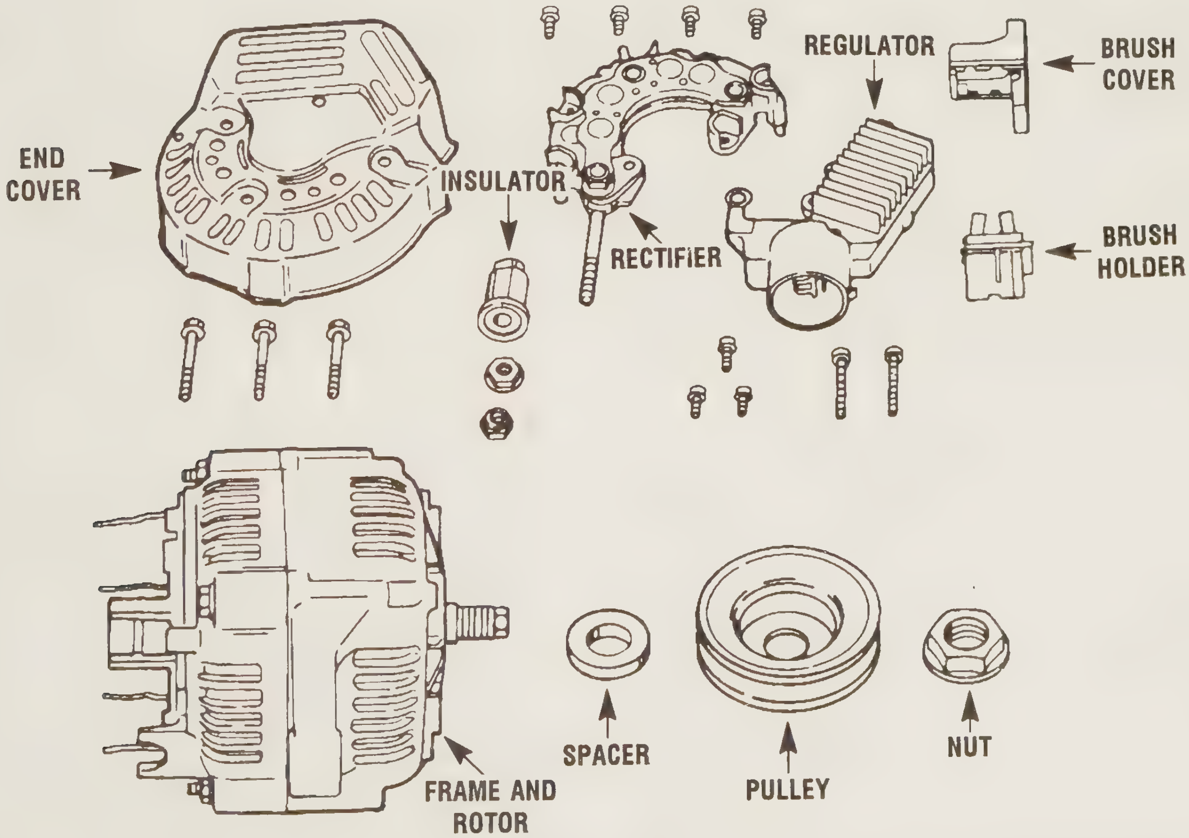
The alternator used on Model 225hp is a 60-amp alternator with an internal voltage regulator and rectifier. If troubleshooting indicates the regulator is defective, the alternator **MUST** be removed from the powerhead, and then disassembled to gain access to the regulator. If additional damage or defective parts internal to the alternator are suspected, the authors recommend the alternator be taken to a local marine dealer or electrical shop specializing in marine electrical systems for further evaluation and testing. The alternator and its replacement parts are manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize the risk of fire and/or explosion. **ALWAYS** use only authorized and approved replacement parts.

Alternator Belt Tension Adjustment

a- Remove the flywheel cover from the powerhead by sliding the cover aft and lifting it at the same time.

b- On top of the alternator, loosen the pivot bolt 1/2 to 3/ 4 turn to allow the alternator to pivot. Next, loosen the belt tension adjustment bolt 1 or 2 turns. Place a large screwdriver between the alternator and the flywheel. Pry outward with the screwdriver to tighten the drive belt. Check the belt tension by pressing inward on the belt, half way between the flywheel and alternator pulley. If there is approximately 1/2" deflection of the belt, the tension is satisfactory. Tighten both the belt tension adjustment bolt and the pivot bolt to a torque value of 40 ft lb (54.2 Nm).

c- Install the flywheel cover by aligning the tabs and sliding the cover forward.



Layout of components and associated hardware for the belt driven alternator installed on the Model 225hp powerhead. Major parts are identified.

Rectifier Testing

The rectifier is primarily used for charging the battery circuit on models with the 16-Ampere stator alternator. The unit is a solid-state sealed unit containing a series of diodes. Because it is a sealed unit, it is non-reparable and **MUST** be replaced if found defective.

If the rectifier is suspected of malfunctioning, perform the Rectifier Troubleshooting Test on pages 7-28 and 7-29. Prior to testing, disconnect the battery leads from the battery. The rectifier may also be tested while installed on the powerhead provided **ALL** wires are disconnected from the rectifier terminals.

Obtain an Ohmmeter and set the meter switches for "Continuity Testing", perform the steps as listed in the Rectifier Troubleshooting Test flow chart.

RECTIFIER REMOVAL

In most cases the rectifier is easily removed, because it is housed under the electrical access cover on the starboard side of the powerhead. **BEFORE** removing the rectifier, **BE SURE** to disconnect the battery leads at the battery, first. Remove the Yellow stator leads, Red positive lead and Gray tachometer lead, if equipped. Remove the two mounting screws securing the rectifier to the powerhead and lift off the rectifier.

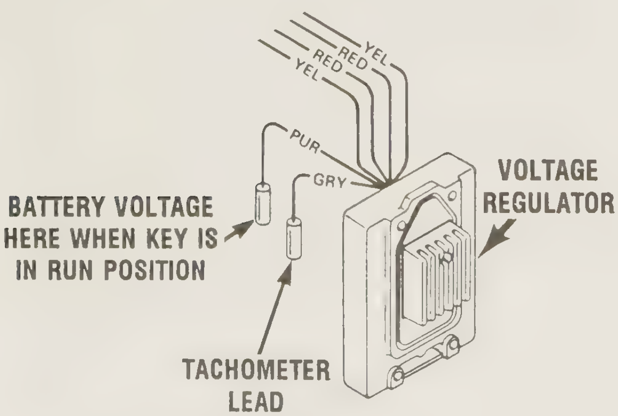
NEVER attempt to check the polarity of the battery leads by sparking the terminals against the battery posts. Such action will burn out the rectifier. A burned-out rectifier in most cases is caused by improper procedures at the battery, or when handling the battery leads as outlined in the following short list.

Wiring harness destroyed by connecting too many accessories through the key switch, as explained in the text.

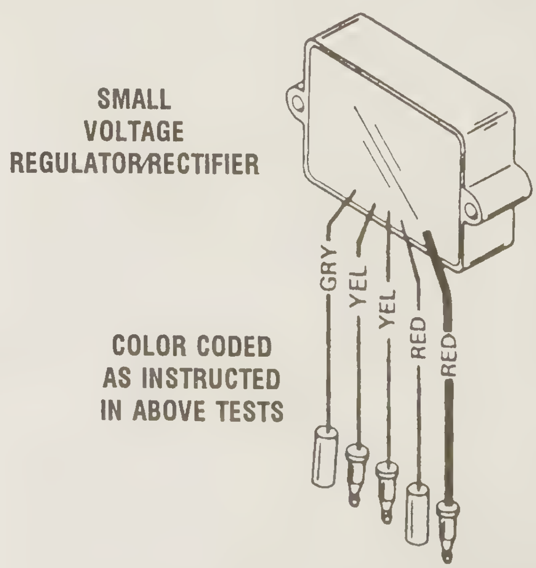
a- The battery leads of the electrical control harness are connected to the wrong terminals at the battery.

b- The battery leads were disconnected from the battery terminals while the powerhead was running.

c- An open circuit resulting from a broken wire, loose connection, corroded switch contact, or a loose harness connector at the powerhead.



Large voltage regulator with color code identification to support the tests in the accompanying table.



Small voltage regulator/rectifier with lead identification for testing as outlined in the above listing.

SMALL VOLTAGE REGULATOR OHMS TEST		
TEST LEADS CONNECTED TO:	OHMS SCALE	METER READING (Ohms)
DIODE CHECK: Connect the negative (-) test lead to either Yellow lead on the regulator. Connect the positive (+) test lead to the thick Red lead on the regulator.	R x 10	100 - 400
DIODE CHECK: Connect the negative (-) test lead to the thick Red lead on the regulator. Connect the positive (+) test lead to either Yellow lead on the regulator.	R x 1K	40K to Infinity
SCR CHECK: Connect the negative (-) test lead to either Yellow lead on the regulator. Connect the positive (+) test lead to case ground.	R x 1K	10K to Infinity
TACHOMETER CIRCUIT CHECK: Connect the negative (-) test lead to case ground. Connect the positive (+) test lead to the Gray lead on the regulator.	R x 1K	10K to 30 K

LARGE VOLTAGE REGULATOR OHMS TEST		
TEST LEADS CONNECTED TO:	OHMS SCALE	METER READING (Ohms)
DIODE CHECK: Connect the negative (-) test lead to either Yellow lead on the regulator. Connect the positive (+) test lead to the thick Red lead on the regulator.	R x 10	100 - 400
DIODE CHECK: Connect the negative (-) test lead to the thick Red lead on the regulator. Connect the positive (+) test lead to either Yellow lead on the regulator.	R x 1K	Infinity
SCR CHECK: Connect the negative (-) test lead to either Yellow lead on the regulator. Connect the positive (+) test lead to case ground.	R x 1K	1K to Infinity
TACHOMETER CIRCUIT CHECK: Connect the negative (-) test lead to case ground. Connect the positive (+) test lead to the Gray lead on the regulator.	R x 1K	9 to 15 Ohms

Rectifier Installation

Place the rectifier in position on the powerhead and secure it with two screws. Tighten the screws to a torque value of 30 in lbs (3.3Nm). Connect the two Yellow leads from the stator to the alternator terminals on the rectifier. If the powerhead is equipped with a tachometer -- connect the Gray wire from the tachometer to one of the Yellow wire terminals on the rectifier. Connect the Red lead from the starter solenoid to the Positive (+) terminal on the rectifier. After all connections are completed, coat all terminals with liquid neoprene Mercury P/N 92-25711 or equivalent, to prevent corrosion on the terminals.

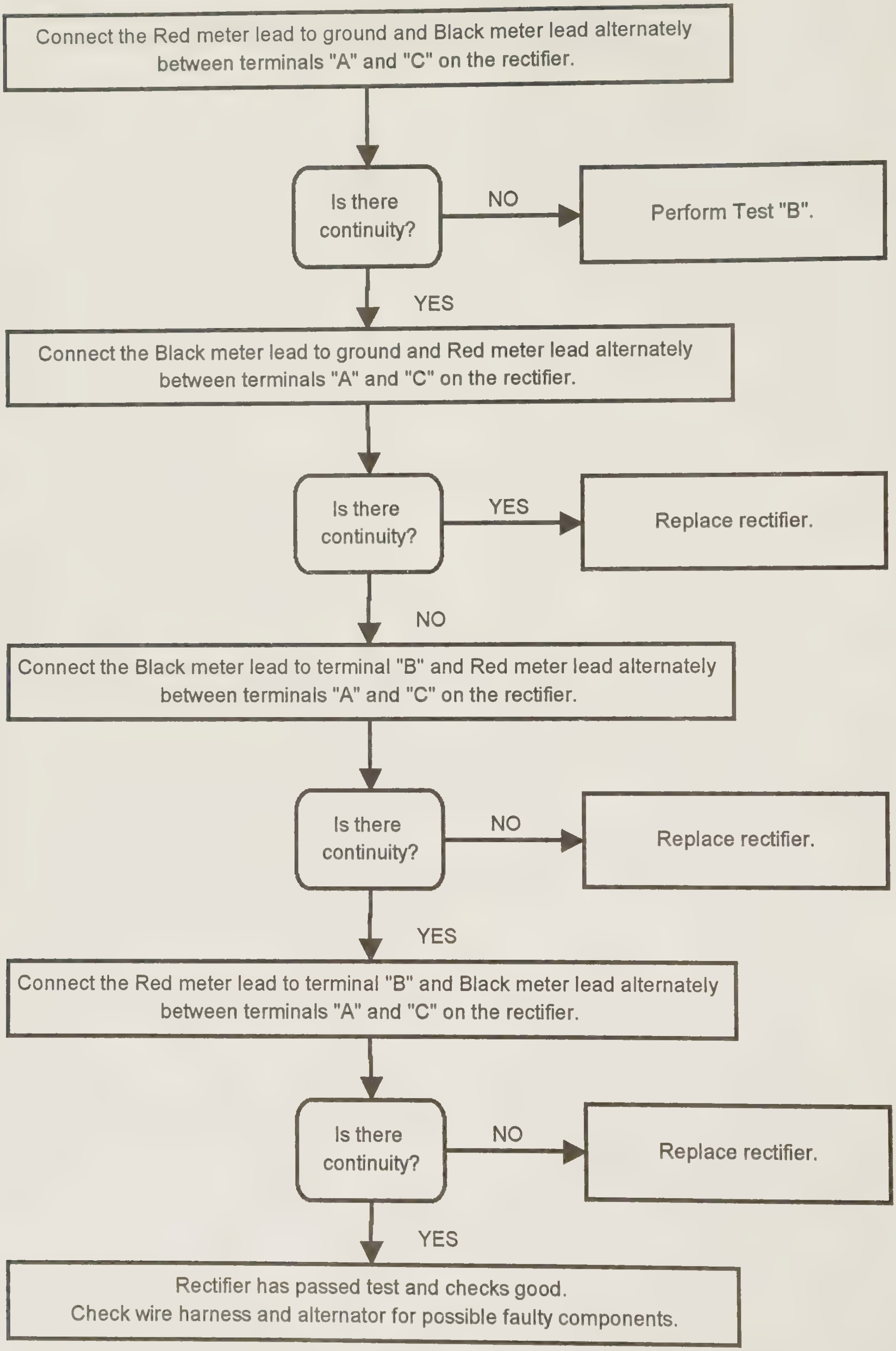
STATOR ALTERNATOR SERVICE

This section provides detailed procedures for testing, removing, and installing the stator alternator.

Stator Alternator Coil Ohms Test

1- The stator may be tested without removing the flywheel, by merely disconnecting the Yellow leads from the terminal block or bullet connectors, depending on the model being serviced. Using an ohmmeter, check the resis-

RECTIFIER TROUBLESHOOTING TEST - "A"



RECTIFIER TROUBLESHOOTING - TEST "B"

Connect the Black meter lead to ground and Red meter lead alternately between terminals "A" and "C" on the rectifier.

Is there continuity? — NO → Replace rectifier.

YES ↓

Connect the Black meter lead to terminal "B" and Red meter lead alternately between terminals "A" and "C" on the rectifier.

Is there continuity? — YES → Replace rectifier.

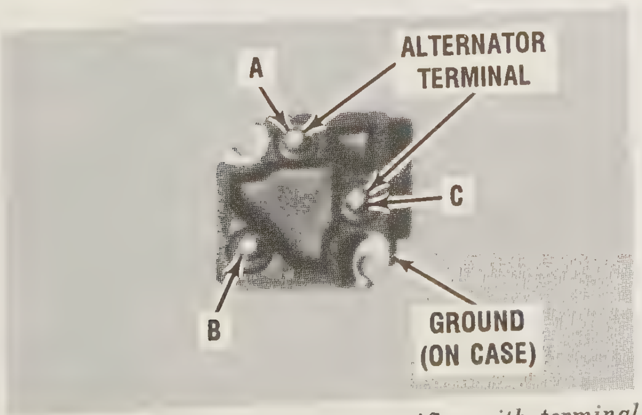
NO ↓

Connect the Red meter lead to terminal "B" and Black meter lead alternately between terminals "A" and "C" on the rectifier.

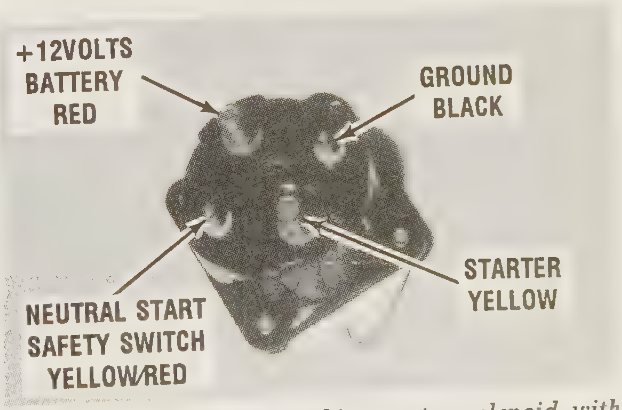
Is there continuity? — NO → Replace rectifier.

YES ↓

Rectifier has passed test and checks good.
Check wire harness and alternator for possible faulty components.



View of a typical voltage rectifier with terminal identification, as mentioned in the text.



View of a typical cranking motor solenoid with terminal identification, as mentioned in the text.

STATOR ALTERNATOR COIL TEST

MODEL	PROCEDURE	OHMS SCALE	METER SCALE
16 Amp Stator with Rectifier and Voltage Regulator	Disconnect both the Yellow stator leads from the rectifier terminals. Connect the Red and Black test leads to each of the stator Yellow leads.	R x 1	.25 - .45 Ohms Note 1
	Connect the Red test lead to either Yellow stator lead. Connect the Black test lead to a good powerhead ground if the stator is installed on the powerhead. Connect the Black test lead to Black wire lead on the stator if removed from the powerhead.	R x 1000	No Continuity
40 Amp Stator with Single Voltage Regulator	Disconnect both the Yellow stator leads from the terminal block at the rear of the powerhead above the ignition coil plate. Connect the Red and Black test leads to each of the stator Yellow leads.	R x 1	0.05 - 0.19 Ohms Note 1
	Connect the Red test lead to either Yellow stator lead. Connect the Black test lead to a good powerhead ground if the stator is installed on the powerhead. Connect the Black test lead to the steel frame of the stator if removed.	R x 1000	No Continuity
40 Amp Stator with Dual Voltage Regulator	Disconnect the two short Yellow and two long Yellow stator leads from the bullet connectors at the rear of the powerhead above the ignition coil plate. Connect the Red and Black test leads to the two short Yellow and the two long Yellow stator leads.	R x 1	.25 - .45 Ohms Note 1
	Connect the Red test lead to one short Yellow (or one long Yellow) stator lead. Connect the Black test lead to a good powerhead ground if stator is installed or to the steel frame of the stator if removed from powerhead.	R x 1000	No Continuity Note 1

tance of the stator windings against those given in the table on this page.

If the stator resistance **DOES NOT** meet the specifications listed in the table, the stator assembly is defective and **MUST** be replaced.

BAD NEWS

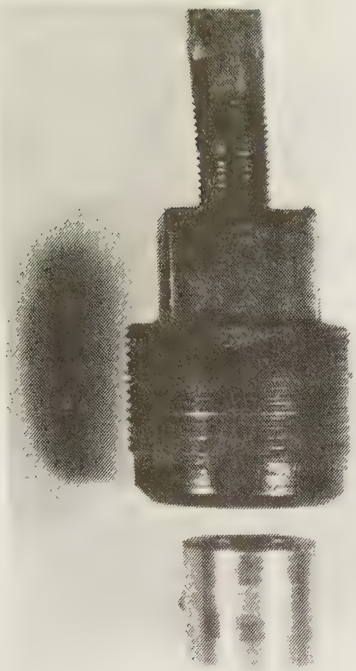
The alternator stator is located under the flywheel. To gain access to the stator the flywheel must be removed -- See Chapter 8.

Stator Alternator Removal

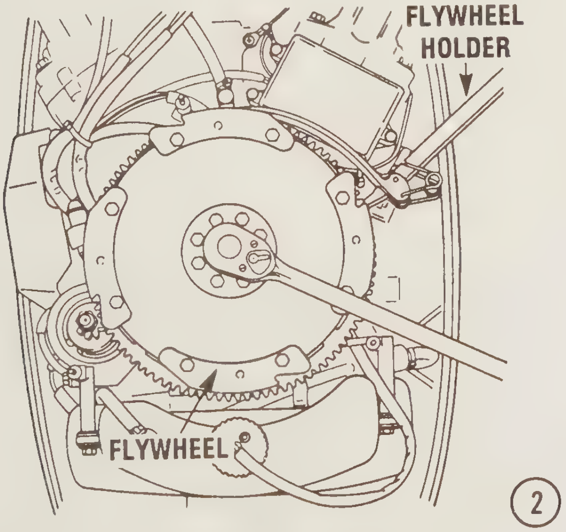
2- Disconnect the battery leads from the battery terminals. Unlatch and lift off the powerhead cowling.

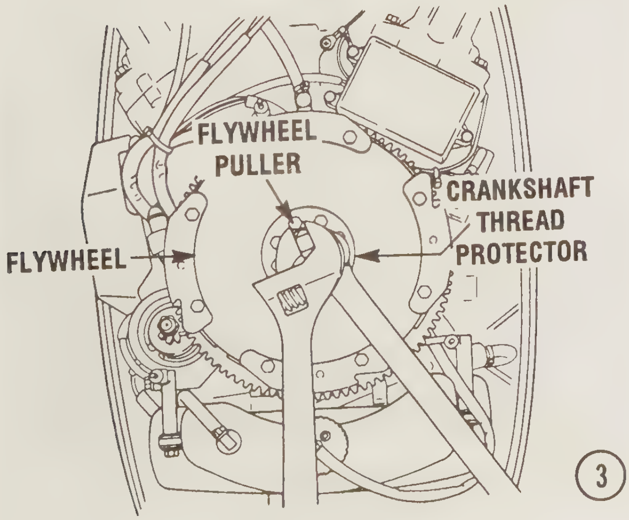
Remove the spark plugs from all cylinders to prevent the powerhead from accidentally starting. Remove the three wing nuts securing the flywheel cover and lift the cover off the powerhead.

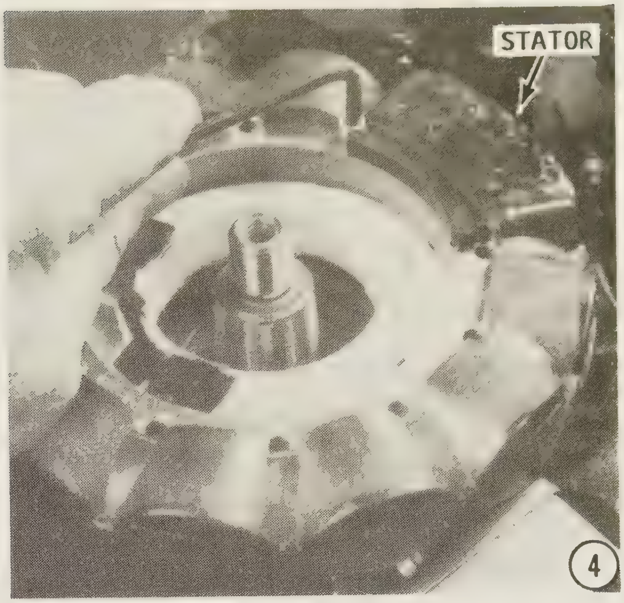
Remove the nut on the crankshaft in the center of the flywheel. A flywheel holding tool, P/N 91-24161, or equivalent, will be required to



Close view of a flywheel removal/installation tool and the tool to protect the threads on the upper end of the crankshaft.



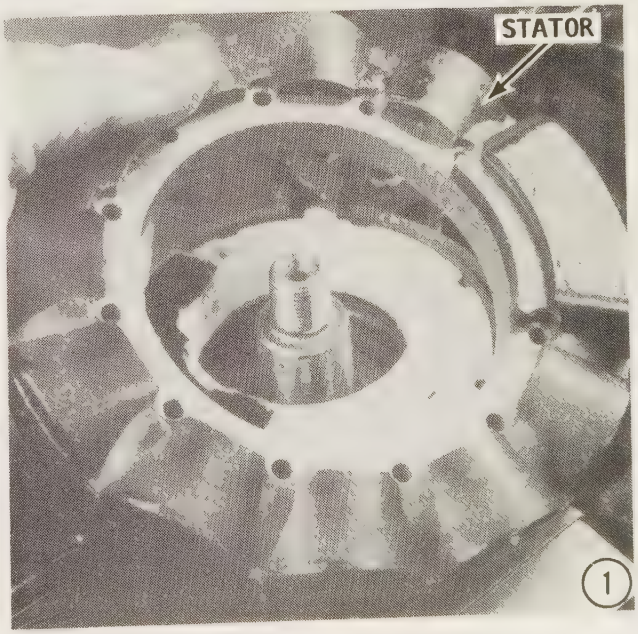




prevent the flywheel from turning in order to loosen the nut.

3- Install crankshaft protector cap P\N 91-24161, or equivalent, over the end of the crankshaft. This cap is used to protect the threads on the end of the crankshaft. Thread flywheel puller P/N 91-73687A1 as far into the flywheel as possible. **NEVER** use a puller which pulls on the outside edge of the flywheel, or the flywheel may be damaged. Hold the outer portion of the flywheel puller tool stationary, and turn the center bolt until the flywheel is free of the crankshaft, and then remove the crankshaft protector tool.

4- Disconnect the wire leads from the stator to the switch box, voltage regulator/rectifier and

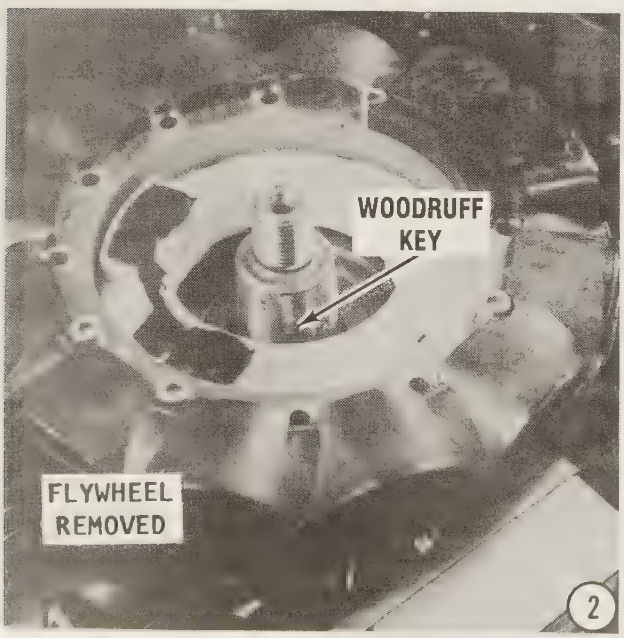


starter solenoid. Remove the cap screws securing the stator to the powerhead and lift the stator from the powerhead.

Stator Alternator Installation

1- Place the stator in position on the powerhead. Coat the threads of the cap screws securing the stator with Loctite 222 or equivalent. Install the cap screws through the stator and into the powerhead. Tighten the screws as follows: Model 135 thru 200hp -- a torque value of 50 in lbs (5.6 Nm). Model 275hp -- the torque value is 150 in lbs (16.9 Nm). Route the stator wire harness down the powerhead exactly as removed. Connect the wire leads from the stator to the voltage regulator/rectifier and switch boxes using the Wiring Diagrams in the Appendix for the model being serviced. Connect all the ground leads to a clean surface. **BE SURE** the switch box leads with Yellow identification sleeves are connected to the outer switch box.

2- Insert the Woodruff key into the crankshaft keyway. Check to be sure the inside taper of the flywheel and the taper on the crankshaft are clean, especially of oil, to prevent the flywheel from "walking" on the crankshaft during operation. Slide the flywheel down over the crankshaft with the keyway in the flywheel aligned with the key on the crankshaft. Rotate the flywheel **CLOCKWISE** a couple turns and check to be sure the flywheel does not contact powerhead components or wiring. Thread the flywheel nut onto the crankshaft, using holding tool P/N 91-52344. Tighten the flywheel nut to following torque values: Model 135 thru 200hp -- 120 ft lbs (162.7 Nm). Model 275hp -- 100 ft lbs (135.6 Nm).



Install the spark plugs and connect the high tension leads to the plugs. Install the flywheel cover over the flywheel and secure it with three wing nuts.

Before considering the job completed, perform the Stator Alternator Output Test for the amperage size stator once again to verify stator operation.

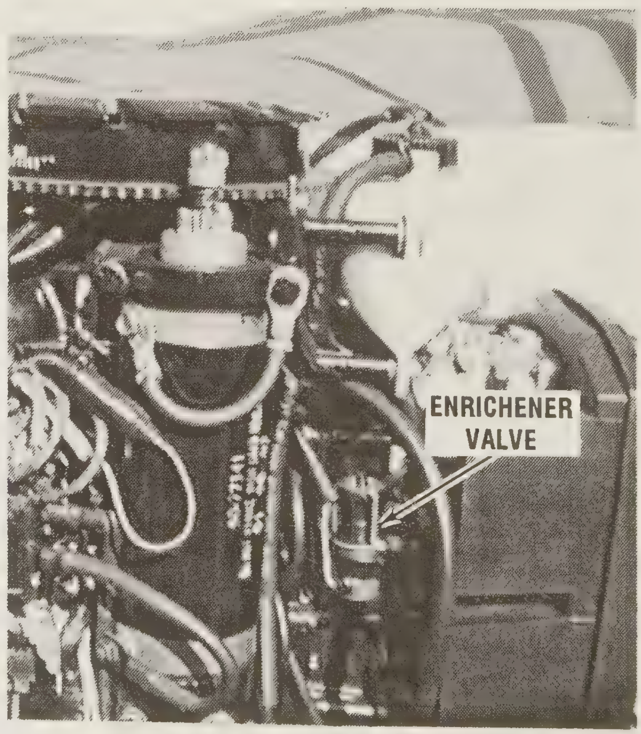
Install the cowling over the powerhead. Connect the battery leads to the battery terminals.

ENRICHENER SYSTEM

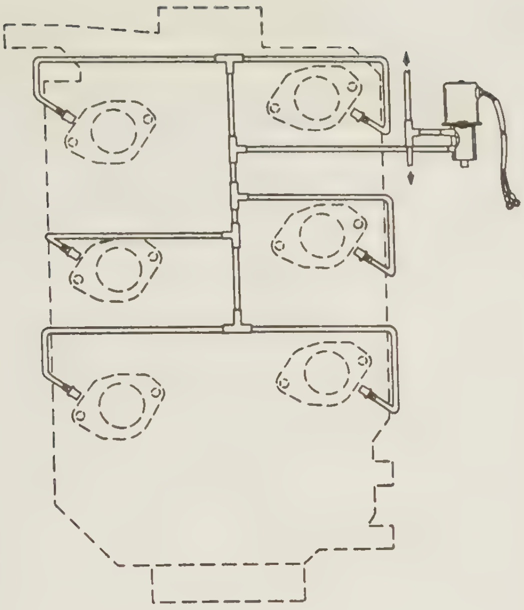
All carburetor equipped powerheads covered in this manual, are equipped with an enrichener system, replacing the traditional choke system.

Description

An electrically operated enrichener valve mounted on the port side of the powerhead, as shown in the accompanying illustration, is supplied with fuel via a fuel line from the float bowl of the top carburetor.



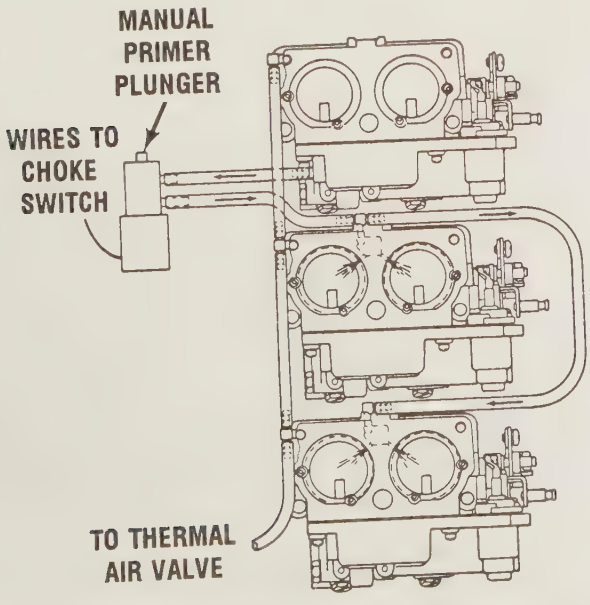
Typical location of the enrichener valve -- shown here on a Model 175hp powerhead.



Layout of the enrichener valve and associated hoses on a Model 275 V6 powerhead.

When the ignition key is rotated to the **ON** position and pushed inward to start a cold powerhead, the enrichener system is energized. Fuel is then fed to all cylinders through short hoses and fittings at the intake manifold close to the carburetor mounting flanges.

As soon as the ignition key is released, electrical current to the system is cutoff; the valve closes; and fuel through the valve stops.



Layout of the enrichener valve and associated hoses for Model 135 thru 225hp V6 powerhead.

Enrichener Valve Circuit Testing

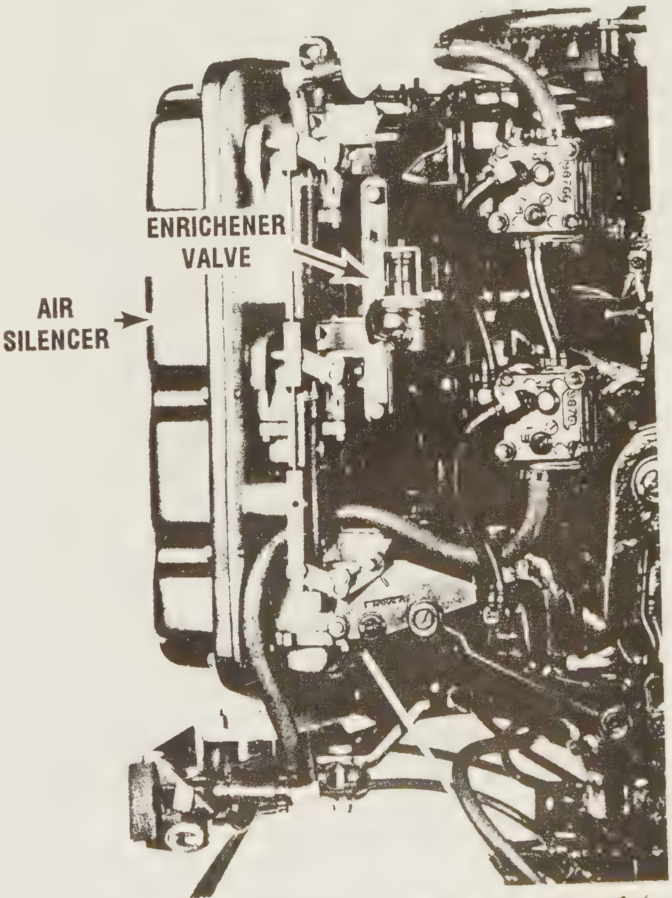
When the system is energized, the ignition switch rotated to the **ON** position and pushed inward, the valve should open. If the valve opens, an audible "click" should be heard at the valve.

If no "click" is heard indicating the valve has not opened, obtain a voltmeter and set the meter to the 12VDC scale. Make contact with the Black meter lead to a suitable ground on the powerhead. Make contact with the Red meter lead to the Yellow/Black lead (from the enrichener valve) at the terminal block on the powerhead. If the meter fails to register 12V, check for an open in the Yellow/Black lead between the ignition switch and the terminal block.

If the meter registers 12V, check for corroded or loose connections at the Yellow/Black lead and the Black lead at the terminal block.

If the enrichener valve still fails to open, no "click" is heard, when the system is energized, replace the valve.

If the "click" is heard but fuel fails to flow from the lower fuel line at the valve,



"Real world" photograph to indicate location of the enrichener valve on a Model 275hp powerhead.

the cause is most likely a blockage or leak in the fuel delivery hose.

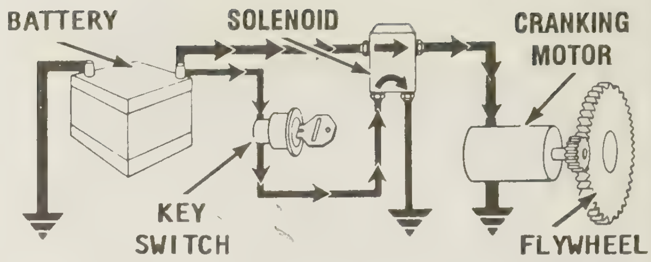
Activate the primer bulb. Disconnect the lower fuel line from the valve. Position a suitable container under the valve and then rotate and push inward on the ignition switch. Fuel should flow from the valve. If fuel flows --all is well with the valve. If the fuel is not reaching a cylinder, the delivery hose to the affected cylinder must have a blockage or leak.

If no fuel flows from the valve; remove the upper fuel delivery hose; hold the container under the disconnected line; activate the primer valve again; and verify fuel is reaching the enrichener valve. If no fuel flows from the disconnected line, the problem is in the top carburetor or delivery hose. The problem may be a blockage in the line or a leak, either in the hose or at a fitting.

If fuel flows from the disconnected delivery line, but fuel fails to flow from the lower fitting when the valve is energized, the enrichener valve is defective and **MUST** be replaced.

The enrichener valve is easily accessible, once the powerhead cowling has been removed, per the illustration on the previous page. The valve is removed by disconnecting the fuel lines and removing the attaching hardware.

Typical Bosch cranking motor used with the powerheads covered in this manual.



Functional diagram of a typical cranking circuit.

BAD NEWS

The enrichener valve cannot be serviced. A new valve must be purchased and installed.

7-8 CRANKING MOTOR CIRCUIT SERVICE

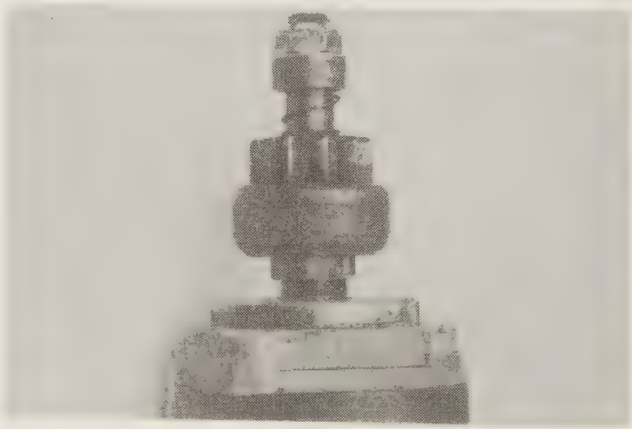
DESCRIPTION

As the name implies, the sole purpose of the cranking motor circuit is to control operation of the cranking motor to crank the powerhead until it is operating.

The circuit includes a solenoid or magnetic switch to connect or disconnect the motor from the battery. The operator controls the switch with a push button or key switch.

A neutral start switch is installed into the circuit to permit operation of the cranking motor **ONLY** if the shift control lever is in **NEUTRAL**. This switch is a safety device to prevent accidental powerhead start when the outboard is in gear.

The cranking motor is a series wound electric motor which draws a very heavy current



*The drive gear moves on the cranking motor shaft during motor operation. Therefore, the shaft should be lubricated with a very small amount of light-weight oil. **TAKE CARE** to prevent the lubricant from entering the cranking motor.*

from the battery. It is designed to be used only for short periods of time to crank the engine for starting. To prevent overheating the motor, cranking should not be continued for more than 30-seconds without allowing the motor to cool for at least three minutes. Actually, this time can be spent in making preliminary checks to determine why the engine fails to start.

Theory of Operation

Power is transmitted from the cranking motor to the engine flywheel through a Bendix drive. This drive has a pinion gear mounted on screw threads. When the motor is operated, the pinion gear moves upward and meshes with the teeth on the flywheel ring gear.

When the engine starts, the pinion gear is driven faster than the shaft, and as a result, it screws out of mesh with the flywheel. A rubber cushion is built into the Bendix drive to absorb the shock when the pinion meshes with the flywheel ring gear. The parts of the drive **MUST** be properly assembled for efficient operation. If the drive is removed for cleaning, **TAKE CARE** to assemble the parts as shown in the accompanying illustration. If the screw shaft assembly is reversed, it will strike the splines and the rubber cushion will not absorb the shock.

The sound of the motor during cranking is a good indication of whether the cranking motor is operating properly or not. Naturally, temperature conditions will affect the speed at which the cranking motor is able to crank the engine. The speed of cranking a cold engine will be much slower than when cranking a warm engine. An experienced operator will learn to recognize the favorable sounds of the powerhead cranking under various conditions.

Faulty Symptoms

If the cranking motor spins, but fails to crank the engine, the cause is usually a corroded or gummy Bendix drive. The drive should be removed, cleaned, and given an inspection.

If the cranking motor cranks the engine too slowly, the following are possible causes and the corrective actions which may be taken:

a- Battery charge is low. Charge the battery to full capacity.

b- High resistance connections at the battery, solenoid, or motor. Clean and tighten all connections.

c- Undersize battery cables. Replace cables with sufficient size.

d- Battery cables too long. Relocate the battery to shorten the run to the solenoid.

Maintenance

The cranking motor requires periodic lubrication of the pinion gear with a thin film of SAE 10W -- once each season if the boat is operated in fresh water or every 60 days if operated in salt water.

The frequency of starts governs how often the motor should be removed and reconditioned. The manufacturer recommends removal and reconditioning every 1000 hours.

Naturally, the motor will have to be removed if the corrective actions outlined under **Faulty Symptoms** above, does not restore the motor to satisfactory operation.

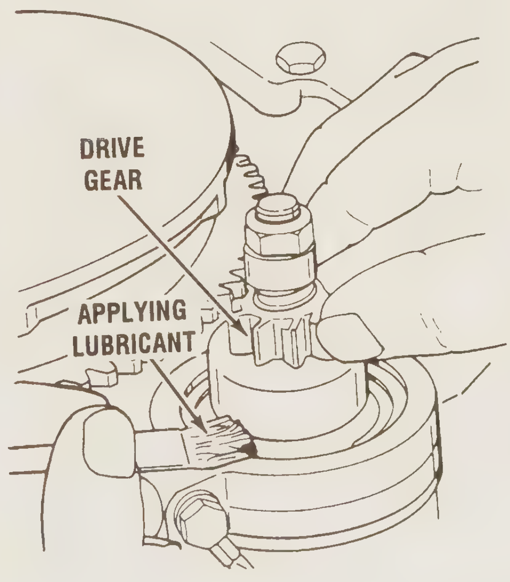
CRANKING MOTOR TROUBLESHOOTING

Before wasting too much time troubleshooting the cranking motor circuit, the following checks should be made. Many times, the problem will be corrected.

a- Battery fully charged.

b- Shift control lever in **NEUTRAL.**

c- All electrical connections clean and tight.



Simple line drawing to depict applying lubricant to the drive gear and collar.

d- Wiring in good condition, insulation not worn or frayed.

Two more areas may cause the powerhead to crank slowly even though the cranking motor circuit is in excellent condition: a tight or "frozen" powerhead and water in the lower unit. The following troubleshooting procedures are presented in a logical sequence, with the most common and easily corrected areas listed first in each problem area. The connection number refers to the numbered positions in the accompanying illustrations.

Perform the following quick checks and corrective actions for the listed problems.

1- Cranking Motor Rotates Slowly

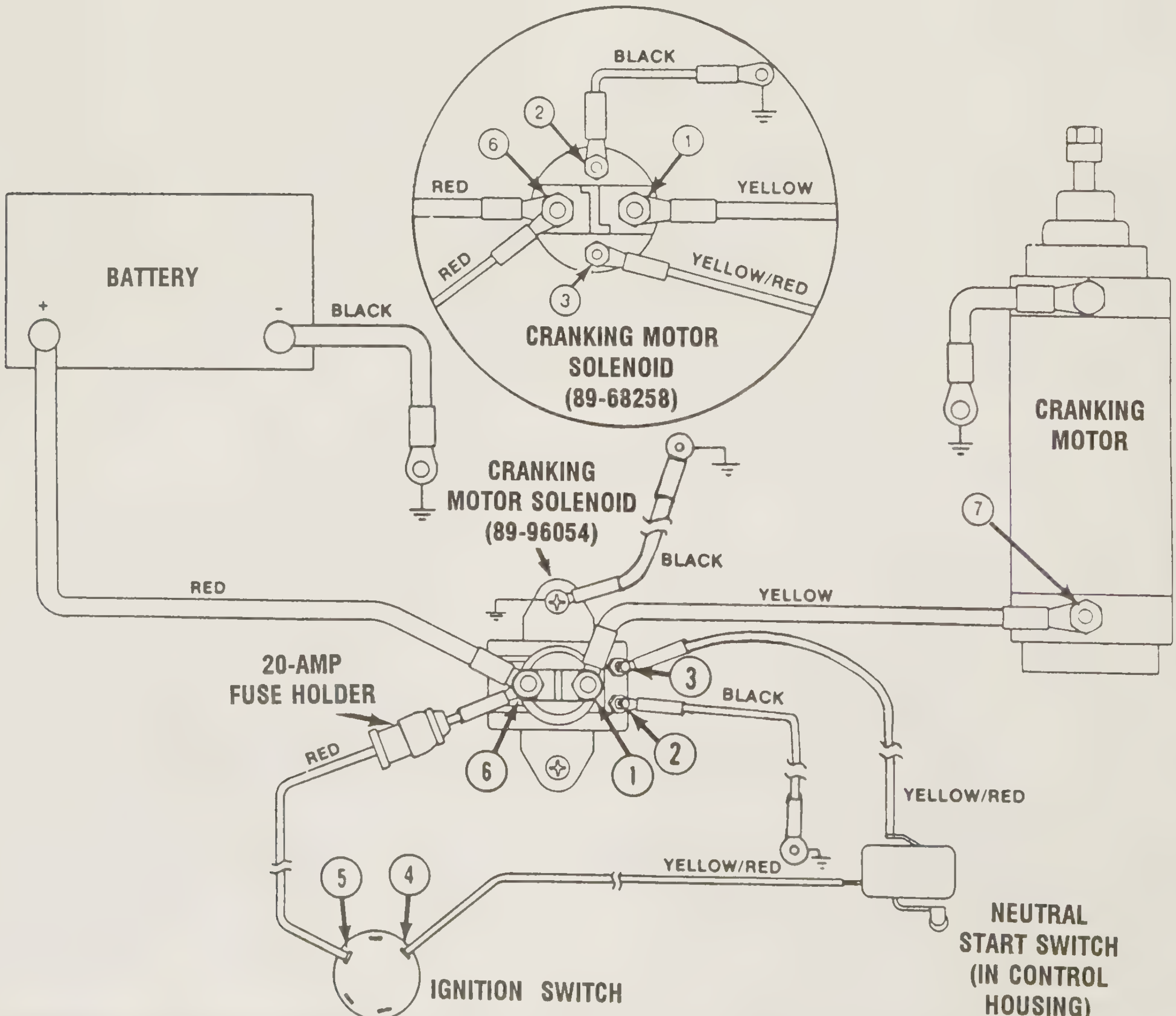
a- Battery charge is low. Correct condition by charging the battery to full charge.

b- Electrical connections are corroded or loose. Clean connections and tighten.

c- Defective cranking motor. Perform an ampere draw test. Place an ampere draw gauge over the positive Yellow cable connecting the cranking motor solenoid to the cranking motor case. Disconnect the spark plug high tension leads from the spark plugs. Have an assistant crank the powerhead for 10 to 20 seconds using the key switch while monitoring the draw gauge. Normal cranking motor amperage draw for Models 135 thru 200hp and Model 275hp is 175 amps under load and 40 amps with no load. The cranking motor amperage draw for Model 225hp is 165 amps under load and 25 amps with no load.

CRITICAL WORDS

The lead from the solenoid to the cranking motor, MUST remain disconnected for tests No.2 thru No.7.



Functional diagram of the cranking motor circuit. The circled numbers are points called out in the text for making specific component tests.

2- Cranking Motor Fails To Crank Powerhead Test Motor

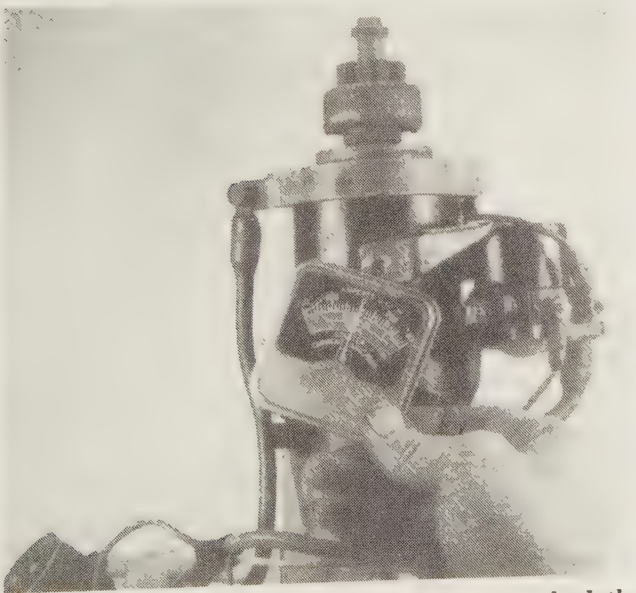
- **a-** Disconnect the lead from the solenoid to the cranking motor.
- **b-** Disconnect the Black ground wire from the No.2 point.
- **c-** Connect a voltmeter between the No. 2 point and a common powerhead ground.
- **d-** Turn the key switch to the **START** position.
- **e-** Observe the voltmeter reading. If there is the slightest amount of reading, check the Black ground wire connection or check for an open circuit. Connect the ground wire back to the No. 2 point and move to Step 7. If there is no voltmeter reading, proceed with Step 3.

3- Test Cranking Motor Solenoid

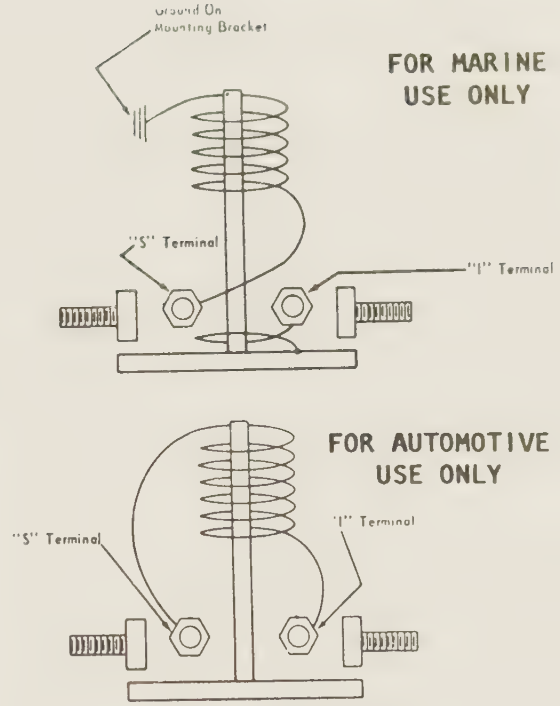
- **a-** Connect a voltmeter between the powerhead common ground and the No. 3 point.
- **b-** Turn the ignition key switch to the **START** position.
- **c-** Observe the voltmeter reading. If there is the slightest indication of a reading, the solenoid is defective and **MUST** be replaced. If there is no reading, proceed with Step 4.

4- Test Neutral Start Switch

- **a-** Connect a voltmeter between the common powerhead ground and the No. 4 point. Turn the ignition key switch to the **START** position.
- **b-** Observe the voltmeter. If there is any indication of a reading, the neutral start switch is open in the shift box or the Yellow/Red wire lead is open between the No. 3 and No. 4 points. If there is no voltmeter reading, proceed to Step 5.



Using a standard ampere draw gauge to check the amount of "draw", as described in the text -- Test No. 1.



Schematic diagram of a marine solenoid (top) and an automotive solenoid (bottom). The marine solenoid has an internal ground and is therefore suitable for outboard installations.

5- Test Ignition Switch

- **a-** Connect a voltmeter between a common powerhead ground and the No. 5 point.
- **b-** Observe the voltmeter. If there is the slightest indication of a reading, the ignition switch is defective and **MUST** be replaced. If there is no reading, proceed with Step 6.

6- Test for Ignition Switch Power

- **a-** Connect a voltmeter between the common powerhead ground and No. 6.
- **b-** If the voltmeter indicates 12-volts, check for a blown 20 amp fuse in the fuse holder or an open circuit in the Red wire between points No. 5 and No. 6. If the meter fails to indicate voltage, check the positive (+) battery terminal and cable to No. 6.

7- **Further Solenoid Tests**

a- Connect the voltmeter between the common powerhead ground and the No. 1 point.

b- Turn the ignition key switch to the **START** position.

c- Observe the voltmeter. If there is no reading, the cranking motor solenoid is defective and **MUST** be replaced. If a reading is indicated and a click sound is heard, proceed to Step 8.

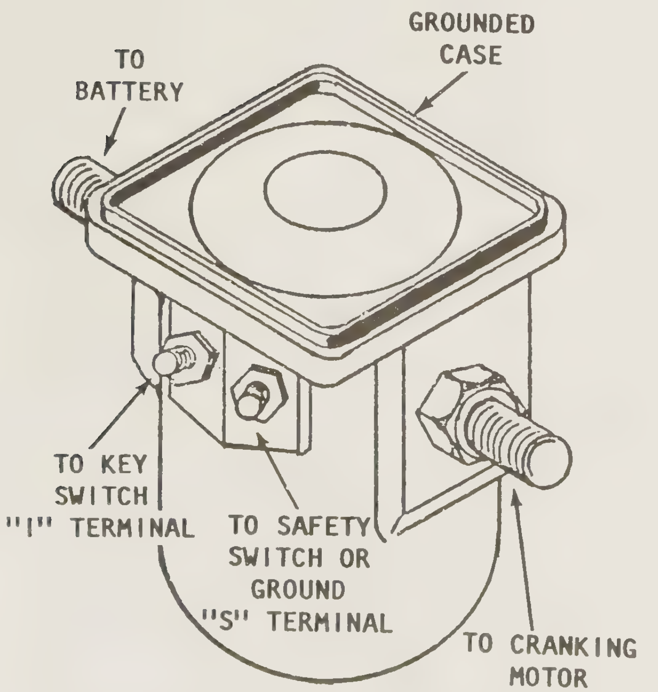
8- **Test Yellow or Black Power Cable**

a- Connect the Yellow or Black lead from the solenoid at point No. 1 to the cranking motor No. 7 point.

b- Connect the voltmeter between the powerhead ground and No. 7

c- Turn the ignition key switch to the **START** position.

d- Observe the voltmeter. If there is no voltage reading, check the Yellow or Black cable from the solenoid No. 1 point to the cranking motor No. 7 point, for a poor connection or open circuit. If there is an indication, check the Black ground cable from the motor to powerhead ground. If the cables are good and connections are tight, then the cranking motor is defective and **MUST** be rebuilt or replaced.



This solenoid acts as a relay in the cranking motor circuit. If the unit is found to be defective it MUST be replaced.

CRANKING MOTOR SOLENOID TROUBLESHOOTING

Description

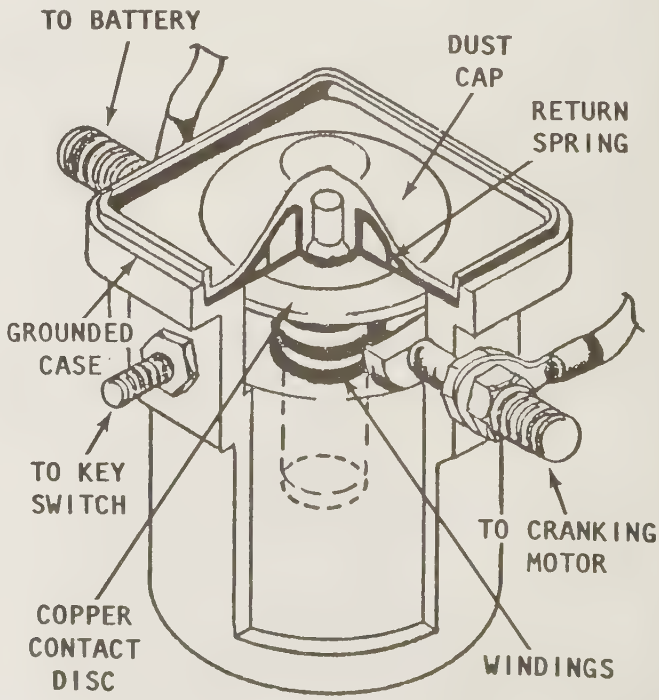
The cranking motor solenoid is a switch between the battery and the motor. Several types of solenoids are used and many look very much alike. For marine applications, a solenoid with an internal ground is used. Grounding this type solenoid is accomplished by a wire internally connected to one of the small terminals. Connecting an external wire for a ground will serve no purpose. **NEVER** attempt to use an automotive-type solenoid, because such a unit will cause more trouble and damage than can be imagined.

When purchasing a replacement solenoid look for a statement on the package indicating the unit is for marine use.

Illustration of several different type solenoids are included in this section as an assist to understanding the operating function of each type.

Solenoid Testing

The following test **MUST** be conducted with the solenoid removed from the powerhead.



A cutaway drawing of a cranking motor solenoid with major parts identified.

a- Connect one test lead of an ohmmeter to each of the large solenoid terminals.
b- Connect the positive (+) lead from a fully charged 12-volt battery to the small solenoid terminal marked **S**.
c- **MOMENTARILY** make contact with the ground lead from the battery to the small solenoid terminal marked I. If a loud "click" sound is heard, and the ohmmeter indicates continuity, the solenoid is in serviceable condition. If, however a "click" sound is not heard, and/or the ohmmeter does not indicate continuity, the solenoid is defective and **MUST** be replaced and only with a **MARINE** solenoid.

CRANKING MOTOR SERVICE

Description

The function of the cranking motor system is to crank the powerhead. The battery supplies electrical energy to the cranking motor through the closed contacts of the solenoid switch. When the ignition switch is turned to the **Start** position, 12VDC power from the battery -- via the 20 Amp fuse -- energizes the solenoid switch and closes the contacts inside the solenoid. Current from the battery now flows through the solenoid and on to the cranking motor. As the cranking motor begins to rotate, the helix splines on the armature force the drive gear **UP** and the teeth of the drive gear engage with the teeth on the flywheel.

When the powerhead fires and begins to operate, the speed of the drive gear is overrun by powerhead speed. A one-way clutch inside the drive gear assembly allows the gear to be driven faster than the cranking motor. Therefore, the cranking motor does not overspeed or drag down the powerhead speed.

When the helmsperson releases the ignition switch from the **START** position to **RUN**, the solenoid switch opens and breaks the current flow to the cranking motor. Once the cranking motor slows, the drive assembly is forced down the helix splines by the return spring. This action dis-engages the drive gear from the flywheel.

The cranking motor circuit is disabled anytime the remote shift lever is in any position other than **NEUTRAL**.

A neutral start switch mounted inside the remote control unit is mechanically actuated by the shift lever. When the shift lever is in the **NEUTRAL** position, the contacts of the switch are closed, completing the circuit to the solenoid switch. When the shift lever is **NOT** in the **NEUTRAL** position, the switch contacts are open and the circuit to the solenoid is disabled, preventing powerhead start-up.

Marine cranking motors installed on the powerheads covered in this manual are of the American Bosch design. They are very similar in construction and operation to the units used in the automotive industry.

NEVER operate a cranking motor for more than 30-seconds without allowing it to cool for at least three minutes. Continuous operation without the cooling period can cause serious damage to the cranking motor.

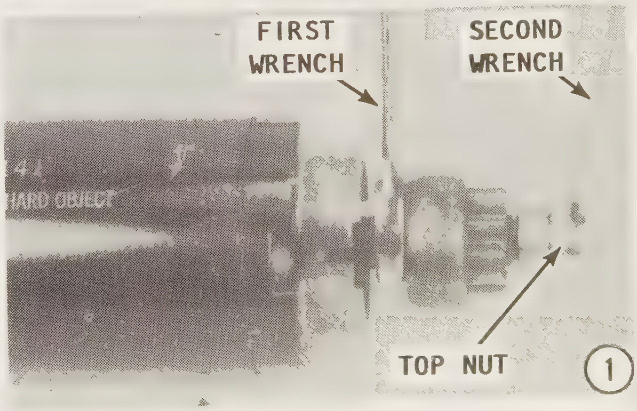
CRANKING MOTOR REMOVAL

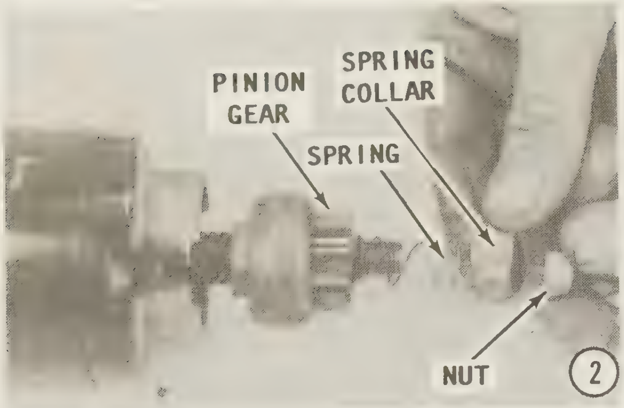
Before beginning any work on the cranking motor, disconnect the positive (+) lead from the battery terminal. Unlatch and remove the cowling from the powerhead. Disconnect the Yellow or Black cable from the solenoid to the cranking motor, at the cranking motor terminal. Disconnect the Black ground cable from the powerhead frame to the cranking motor. Remove the clamp bolts, clamps and cranking motor from the powerhead.

DISASSEMBLING PINION GEAR WITH TOP SPRING

This type cranking motor uses a top spring to push the pinion gear down.

1- Move the pinion gear upward and place a wrench on the bottom side of the gear. Now, place a second wrench on the top nut. Hold firm with the first wrench and with the other wrench, back-off the nut. Remove and **DISCARD** the nut. Do not attempt to use the same nut a second time.





2- Remove the spring collar, spring, and pinion gear. If other work is to be performed on the cranking motor, proceed directly to the cranking motor repair section of this chapter.

CLEANING AND INSPECTING

Inspect the pinion gear teeth for chips, cracks, or a broken tooth. Check the splines inside the pinion gear for burrs and to be sure the gear moves freely on the armature shaft.

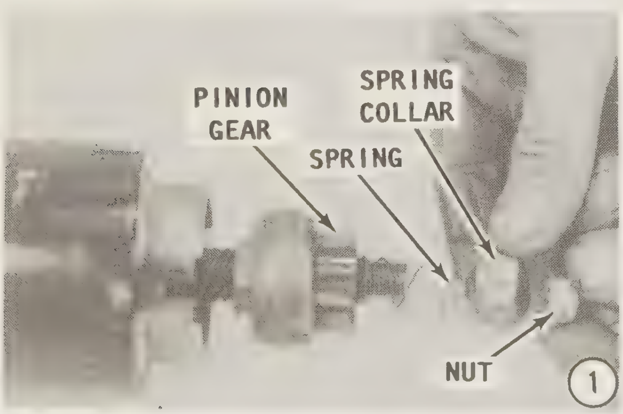
BAD NEWS

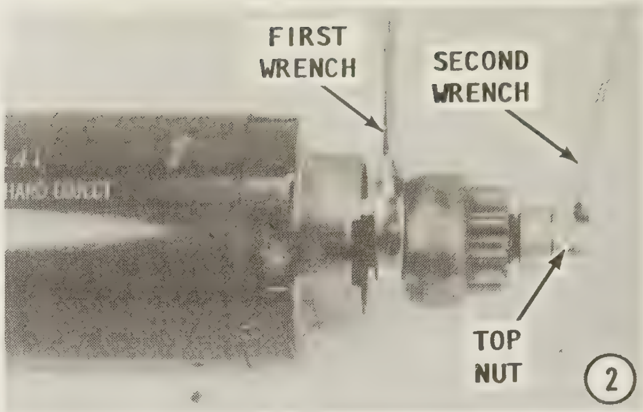
This type cranking motor pinion gear assembly cannot be repaired if the unit is defective. Replacement as a complete unit is the only answer.

Clean the armature shaft and check to be sure the shaft is free of any burrs. If burrs are discovered, they may be removed with crocus cloth.

ASSEMBLING PINION GEAR WITH TOP SPRING

1- Slide the pinion gear onto the armature shaft, then the spring and the spring collar. Start a **NEW** nut onto the armature shaft.





2- Place a wrench on the bottom side of the pinion gear and a second wrench on the nut. Hold firm with the first wrench and tighten the nut with the second wrench.

CRANKING MOTOR DISASSEMBLING

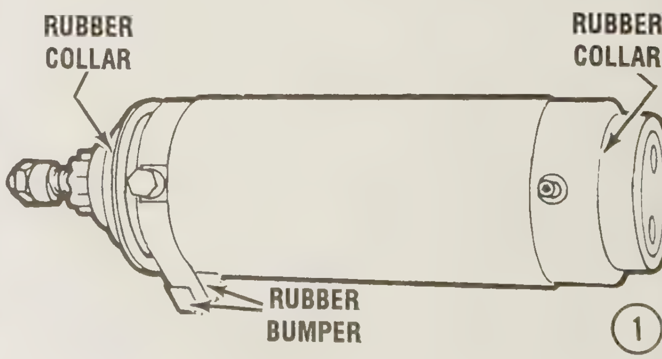
GOOD NEWS

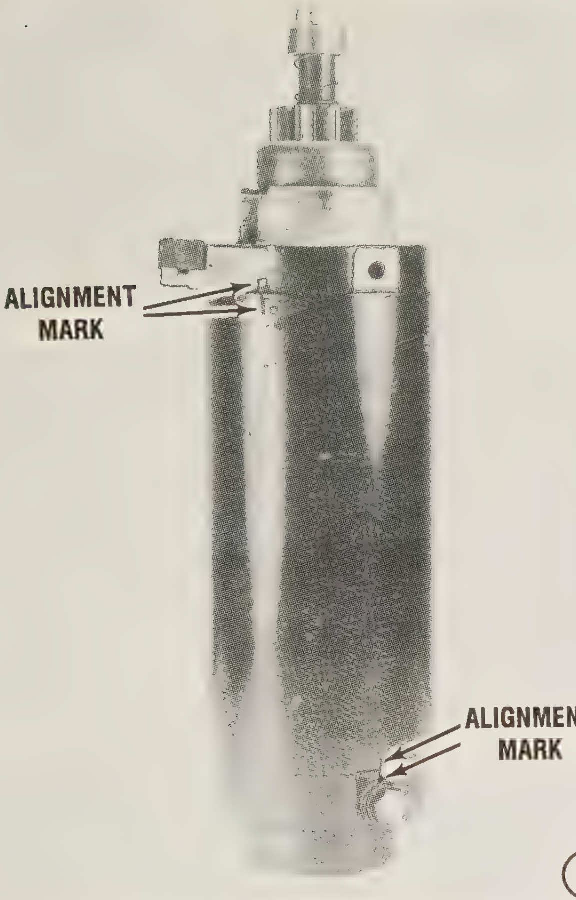
If the only motor repair necessary is replacement of the brushes, the pinion gear does not have to be removed. All cranking motors have thru-bolts securing the upper and lower caps to the field frame assembly. In all cases both caps have some type of mark or boss. These marks are used to properly align the caps with the field frame assembly.

1- Remove the rubber bumpers from the upper end cap. Remove the rubber collars from the upper and lower end caps, if equipped.

2- Observe the caps and find the identifying mark or boss on each cap. If the marks are not visible, make new identifying marks on the caps and frame, prior to removing the thru-bolts. These marks are **ESSENTIAL** during assembling.

3- Loosen and unscrew the two thru-bolts from the upper end cap, and then slide the thru-bolts out of the frame assembly.





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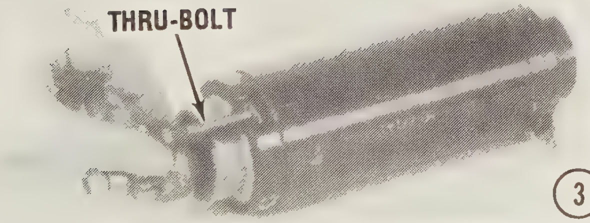

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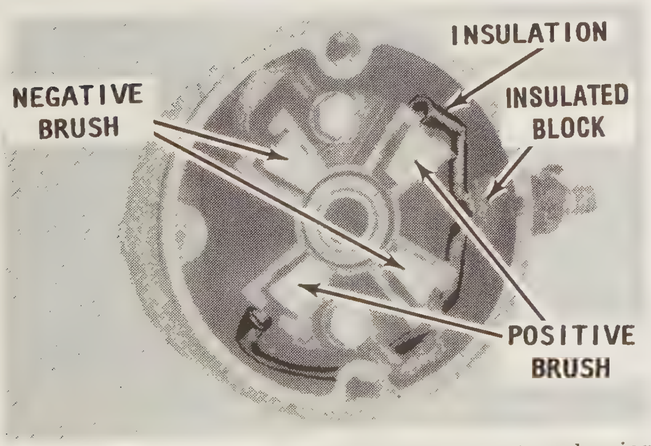


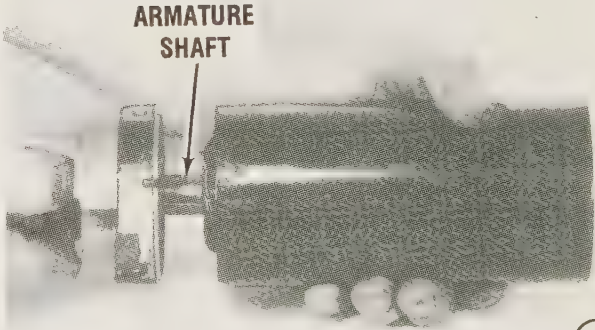
The end cap of a Bosch cranking motor showing arrangement of the positive and negative brushes.

4

4- Remove the lower end cap (commutator end) from the frame. The brushes and holder are mounted inside the end cap.

5- Pull on the armature shaft from the drive gear end and remove it from the field frame assembly.

6- Remove the brushes from their holders, and then remove the brush springs.



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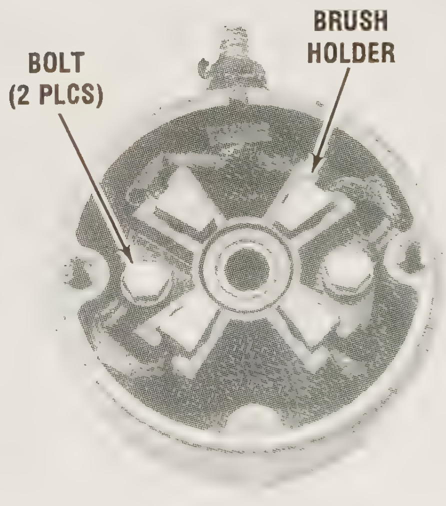

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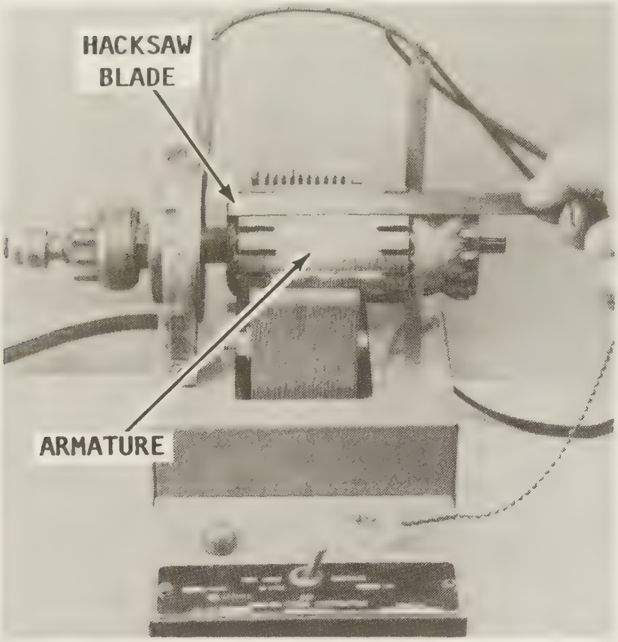


Using a hacksaw blade to check the armature of a Bosch cranking motor on a growler. If the hacksaw blade vibrates, the armature has a short.

TESTING CRANKING MOTOR PARTS

SPECIAL WORDS

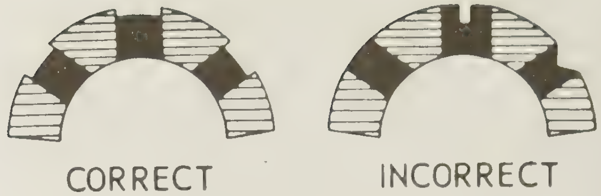
Most marine shops and all electrical motor rebuild shops will test an armature for a modest charge. If the armature has a short, it **MUST** be replaced.

Check the armature for a short circuit by placing it on a growler and holding a hack saw blade over the armature core while the armature is rotated. If the saw blade vibrates, the armature is shorted. Clean between the armature bars, and then check again on the growler. If the saw blade still vibrates, the armature must be replaced. Occasionally carbon dust from the brushes will short the armature. Therefore, blow the slots in the armature clean with compressed air.

Make contact with one probe of the test light on the armature core or shaft. Make contact with the other probe on the commutator. If the light comes on, the armature is grounded and must be replaced.

Turning the Commutator

True the commutator, if necessary, in a lathe. **NEVER** undercut the mica because the brushes are harder than the insulation. Undercut the insulation between the commutator bars 1/32" (0.80mm) to the full width of the insulation and flat at the



Comparison of armature segments properly cleaned (left) and improperly cleaned (right).

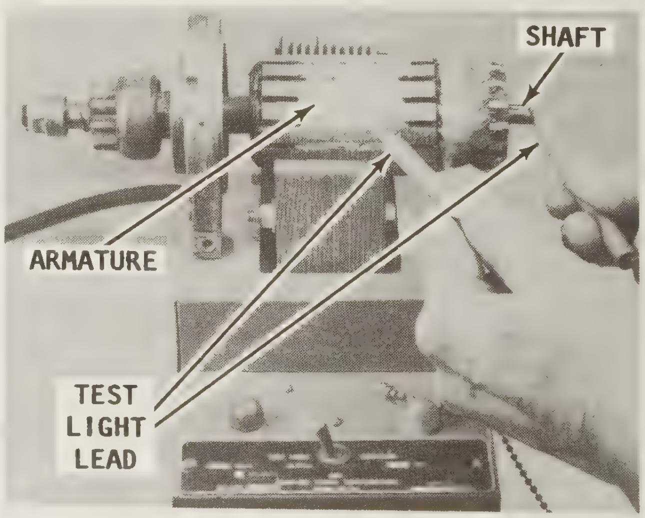
bottom. A triangular groove is not satisfactory. After the under-cutting work is completed, clean out the slots carefully to remove dirt and copper dust. Sand the commutator lightly with No. 00 sandpaper to remove any burrs left from the undercutting. Test light probes placed on any two commutator bars should light and indicate continuity. Check the armature a second time on the growler for possible short circuits.

Positive Brush Testing

Obtain an ohmmeter. Connect each lead of the meter to one of the positive brushes. The ohmmeter **MUST** indicate continuity between the brushes. If the meter indicates any resistance, check the lead to the brush and the lead to the positive terminal solder connection. If the connection cannot be repaired, the brush set **MUST** be replaced. Test the second brush in the same manner.

Negative Brush Testing

Obtain an ohmmeter. Make contact with one test lead on one negative brush and make



Checking Bosch cranking motor armature to be sure there is NO continuity between the armature core and the armature shaft.

ontact with the other test lead on the end cap bare metal). The meter should indicate **NO** continuity. Move the test lead to the other negative brush. Once again, the meter should indicate **NO** continuity. If continuity is observed on the meter for either brush, the negative brushes **MUST** be replaced.

CLEANING AND INSPECTING

Clean the field coils, armature, commutator, armature shaft, brush-end plate and drive-end housing with a brush or compressed air. Wash all non-electrical parts in solvent and blow them dry with compressed air.

Inspect the insulation and the unsoldered connections of the armature windings for breaks or burns.

Perform electrical tests on any suspected defective part, according to the procedures outlined in this section.

Check the commutator for "run-out". Inspect the armature shaft and both bearings for scoring.

Turn the commutator in a lathe if it is out-of-round by more than 0.005" (0.13mm).

Check the springs in the brush holder to be sure none are broken. Check the spring tension and replace it if the tension is not 32-40 ounces (900-1135 gm). Check the insulated brush holders for shorts to ground. If the brushes are worn down to 1/4" (6.35mm), or less, they **MUST** be replaced.

Check the field brush connections and lead insulation. A brush repair kit is available at the local marine dealer, but all other assemblies must be replaced rather than repaired.

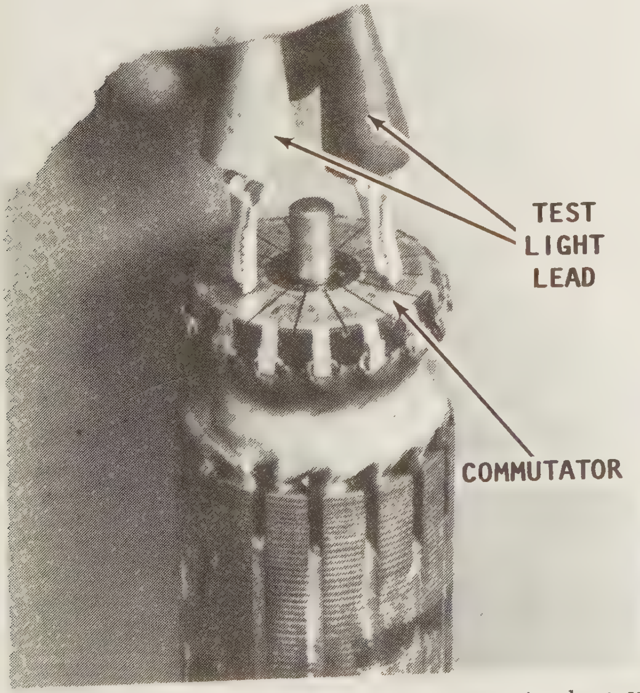
The armature brushes and brush holders must be checked before assembling the cranking motor. See the testing section in this chapter for detailed procedures to test the cranking motor.

Bosch Brushes

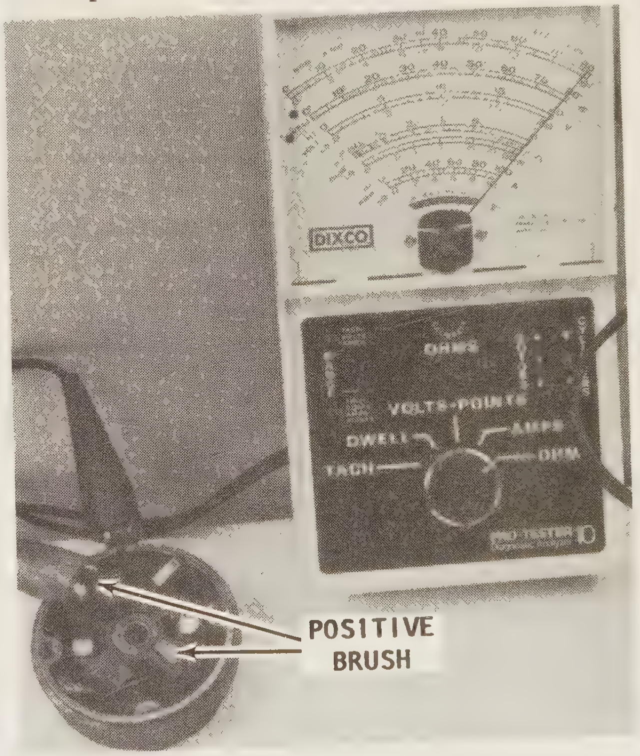
Both the positive and negative brushes on a Bosch cranking motor are mounted in the lower cap. The positive brushes are attached to the positive terminal and are sold as an assembled set. The negative brushes are attached to the lower cap with a bolt.

To remove the positive brushes, slip the terminal out of the slot in the cap. The negative brushes are removed by simply removing the two bolts attaching the brush lead to the lower cap.

Installation of the new positive brushes is accomplished by sliding the new positive termi-



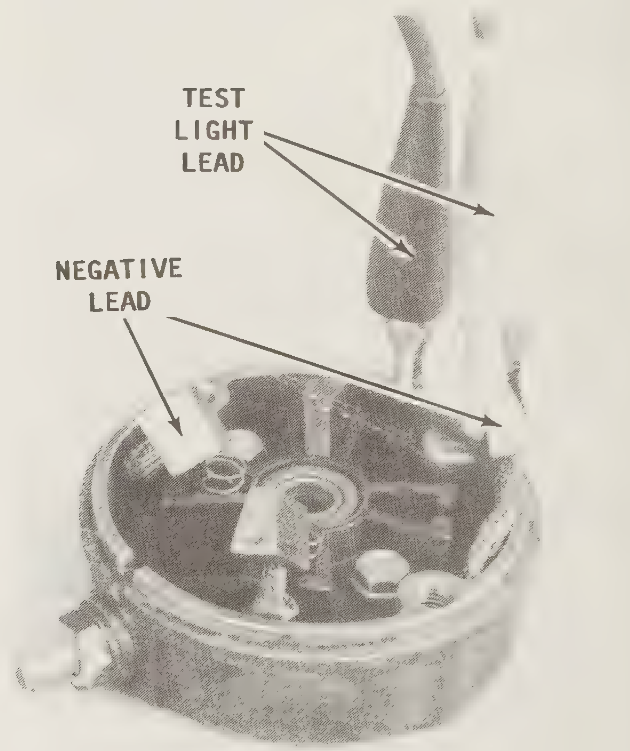
Checking the continuity of the commutator bars on a Bosch cranking motor armature. If the test light leads make contact with any two bars the light should come on to indicate continuity.



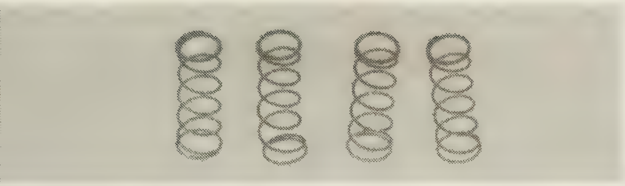
Checking the positive brushes on the end cap of a Bosch cranking motor. One test lead is connected to the positive terminal of the cap; the other lead is alternately touched to the positive brushes. Continuity must be indicated.

Exploded drawing of a Bosch cranking motor covered in this chapter. Major parts have been identified.

Example of a questionable end cap removed from a Bosch cranking motor. Note the loose spring escaped from beneath one of the brushes. A unit in this condition must be carefully inspected, cleaned, and worn parts replaced before returning it to service.



Checking the field brushes on the end cap of a Bosch cranking motor. One test lead is connected to the frame; the other lead is connected alternately to the brush leads. Continuity must be indicated.



Springs from a Bosch cranking motor. The springs must all be the same height, have the same amount of tension and show no sign of overheating.

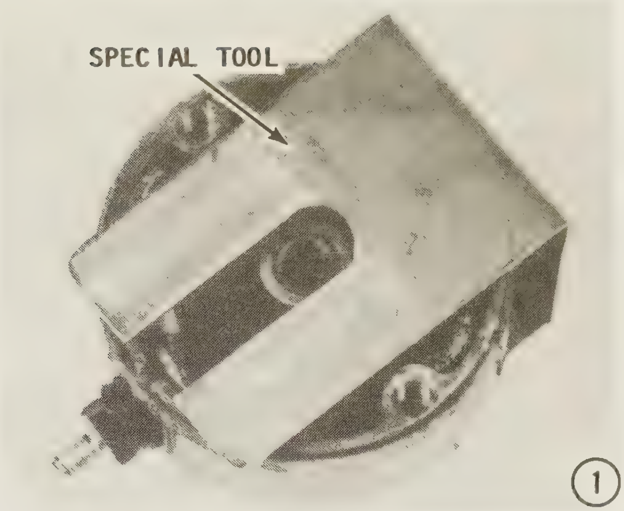
nal into the slot of the end cap. Install the negative brushes by positioning them in place in the lower cap, and then securing the leads with the attaching bolts.

ASSEMBLING BOSCH CRANKING MOTOR USING SPECIAL TOOL

Make a tool, as shown in the accompanying illustration, to prevent the brushes from being damaged during installation of the commutator end cap. If a special tool is not available, see "Assembling Bosch Cranking Motor Without Special Tool", on Page 7-46.

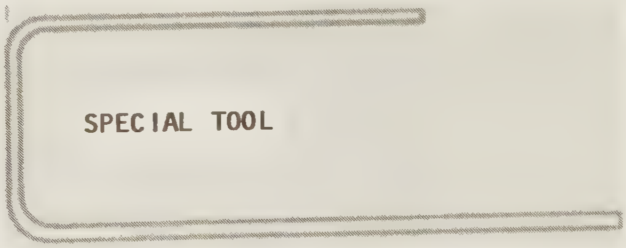
1- Slide the brush springs into the brush holder, and then insert the brushes into the holder while compressing the springs. Position the special tool over the end cap and brushes to hold the brushes in place. Place one or two drops of SAE 10W oil into the lower end cap bushing.

2- Lubricate the helix threads on the armature, drive gear and the upper end cap bushing with a few drops of SAE 10W oil. Slide the washer over the armature drive end and down onto the armature. Slide the upper end cap

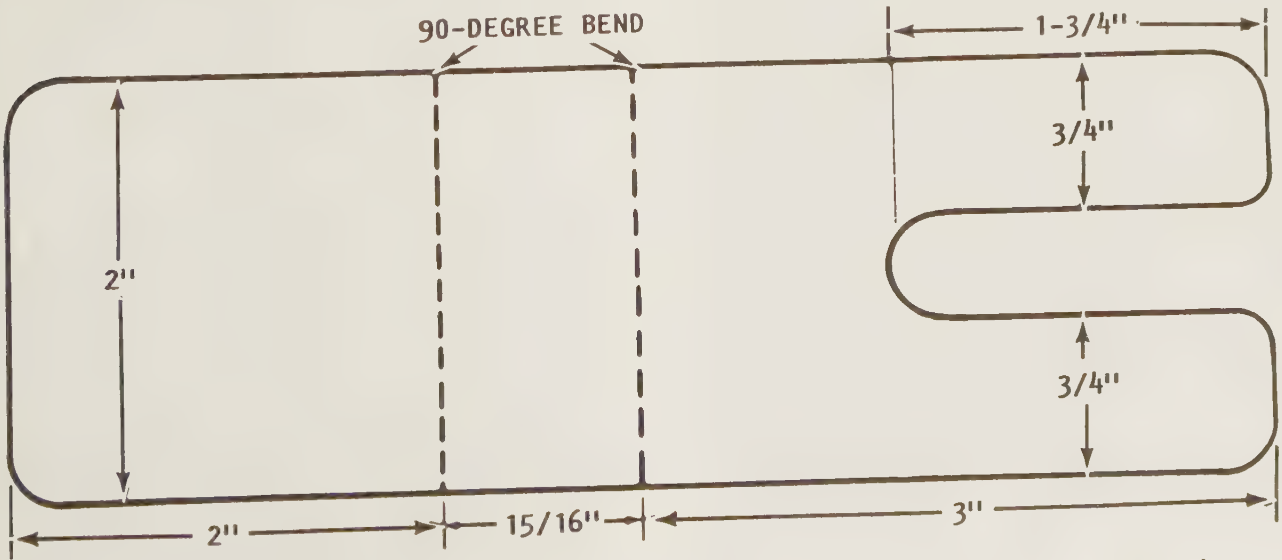


down the armature shaft followed by the drive gear, return spring, collar and new lock nut. Hold the armature stationary with a wrench under the drive gear and tighten the lock nut securely.

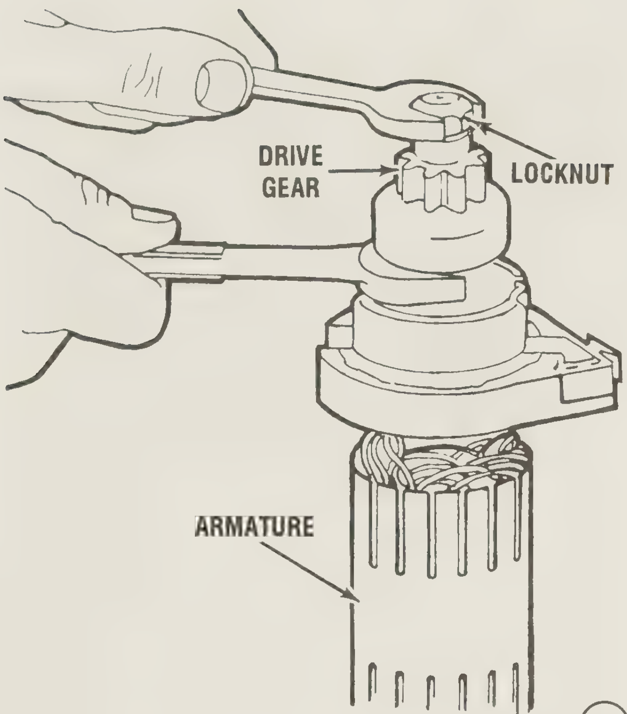
3- Slide the drive end of the frame over the armature and up against the upper end cap.



Special tool required to install the end cap on a Bosch cranking motor. If this tool is not available, special instructions to fabricate one including an illustration is included below.



Working diagram for making a special tool to hold the brushes in place during installation of a Bosch end cap.



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Rotate the frame or upper end cap and align the mating assembly marks made in Step 2 of disassembly -- Page 7-40.

4- Position the lower end cap onto the frame assembly. Lower the cap as far as it will go, and then remove the special tool. Now, align the mark on the cap with the mark on the frame, and then install the thru-bolts and tighten them securely.

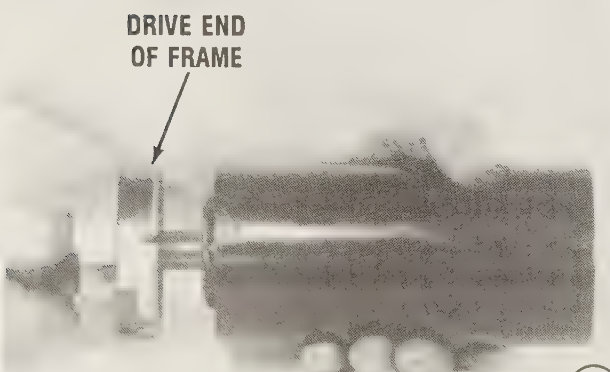
5- Place the cranking motor on the floor. To test operation of the motor, first connect one lead from a set of jumper cables to the positive terminal of a battery. Connect the other end of the same lead to the positive terminal of the motor. Connect the second lead of the jumper cables to the negative battery terminal.

Now, hold the motor firmly on the floor with one foot, as shown, and at the same time, **MOMENTARILY** make contact with the other end of the second jumper lead to the cranking motor case. The pinion gear should spin rapidly.

Slide the rubber collars and spacer onto the starter, if they are used. Install the cranking motor onto the powerhead and secure it in place with the clamps and mounting bolts. Check to be sure the Black ground cable is attached with the lower mounting bolt. Connect the Black ground cable to the negative (-) cranking motor terminal and the Yellow cable to the positive (+) terminal. Install the powerhead cowling and latch it closed. Connect the positive (+) lead to the battery terminal.

Assembling Bosch Cranking Motor Without Special Tool

1- Install the brush springs into the brush holder, and then place each brush on top of the springs. Lay the end cap on the bench with the brushes facing up. Pickup the armature and



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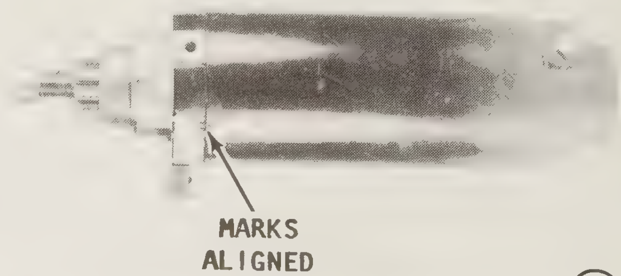

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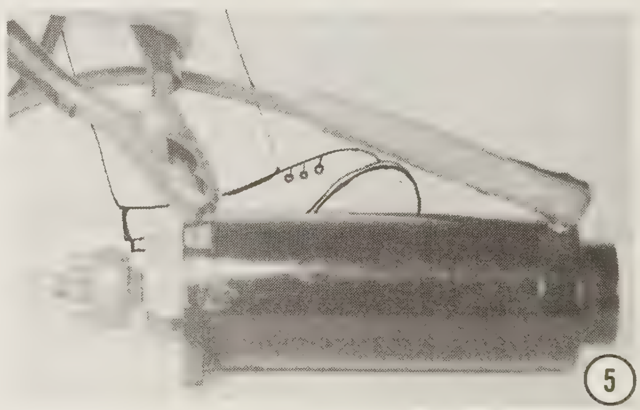

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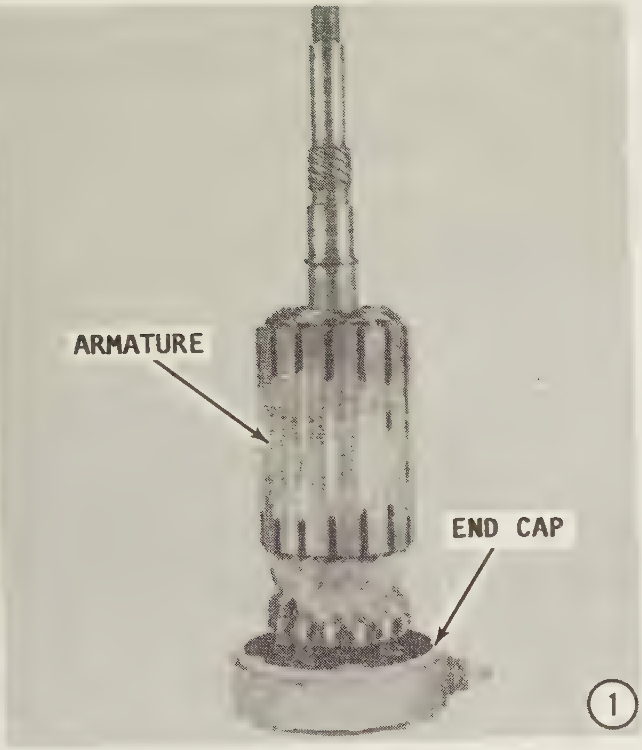
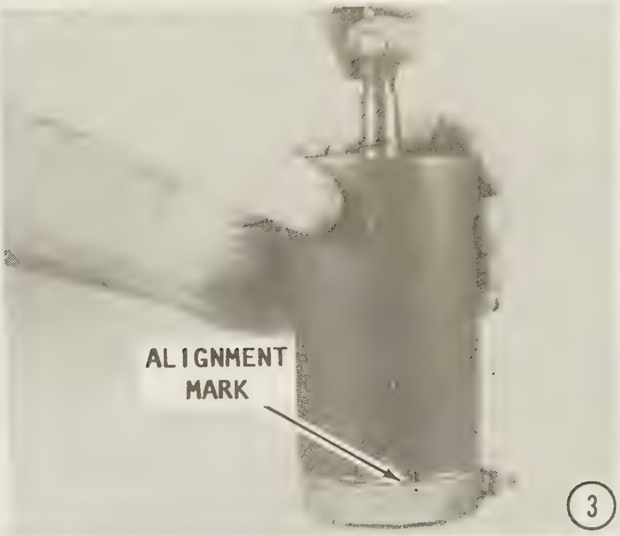
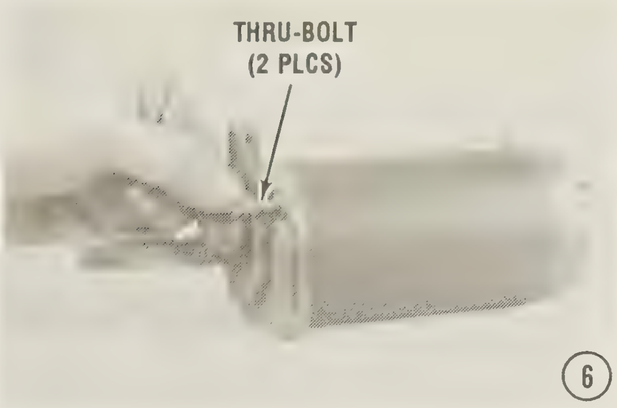


place the commutator on top of the brushes. Lower the armature and at the same time, work each brush into its holder. Continue to lower the armature until the full weight of the armature is on the brushes.

2- Now, very **CAREFULLY** lower the frame assembly down over the armature. **TAKE CARE** because the magnets in the frame assembly will tend to "pull" against the armature.

3- When the frame makes contact with the lower cap, align the marks on the cap and the frame.





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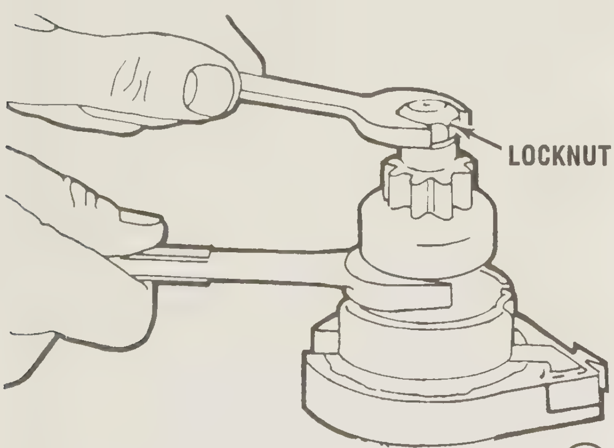
4- Slide the upper cap washer onto the shaft.

5- Install the upper cap with the mark on the cap aligned with the mark on the frame.

6- Install the thru-bolts and tighten them securely. Install the pinion gear and secure it in place with a **NEW** locknut.

7- Lubricate the helix threads on the armature, drive gear and the upper end cap bushing with a few drops of SAE 10W oil. Slide the drive gear, return spring and collar over the armature shaft. Thread a new lock nut onto the end of the armature shaft. Hold the armature stationary with a wrench under the drive gear and tighten the lock nut securely.

8- Place the cranking motor on the floor. To test operation of the motor, first connect one lead from a set of jumper cables to the positive terminal of a 12-volt battery. Connect the other end of the same lead to the positive terminal of the motor. Connect one end of the second jumper cable lead to the negative battery terminal.



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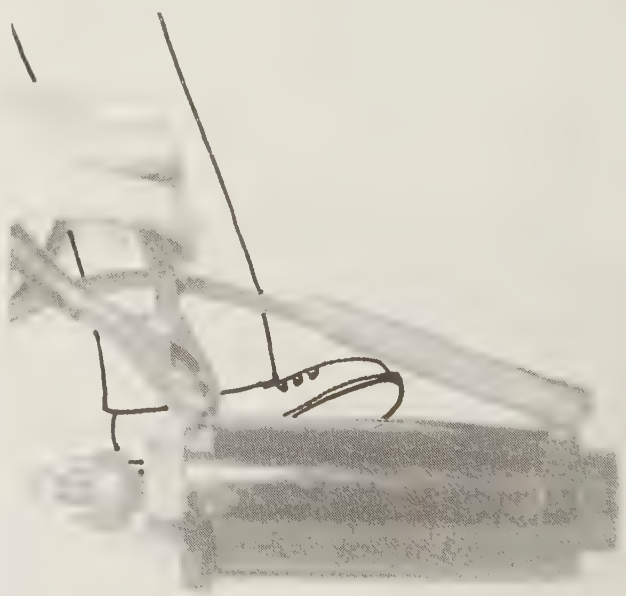
Now, hold the motor firmly on the floor with one foot, as shown, and at the same time, **MOMENTARILY** make contact with the other end of the second jumper lead to the cranking motor case. The pinion gear should spin rapidly.

Slide the two rubber collars onto the upper and lower ends of the cranking motor end caps. Install the rubber bumpers on the upper end cap, if equipped. Install the cranking motor onto the powerhead and secure it in place with the clamps and mounting bolts. Connect the Black negative (-) battery cable to the lower clamp bolt and the upper Black negative (-) cable from the motor frame ground terminal to one of the upper clamp bolts. Connect the Yellow or Black positive (+) cable to the positive terminal on the cranking motor. Install the powerhead cowling and latch it closed. Connect the positive (+) battery cable to the battery.



8

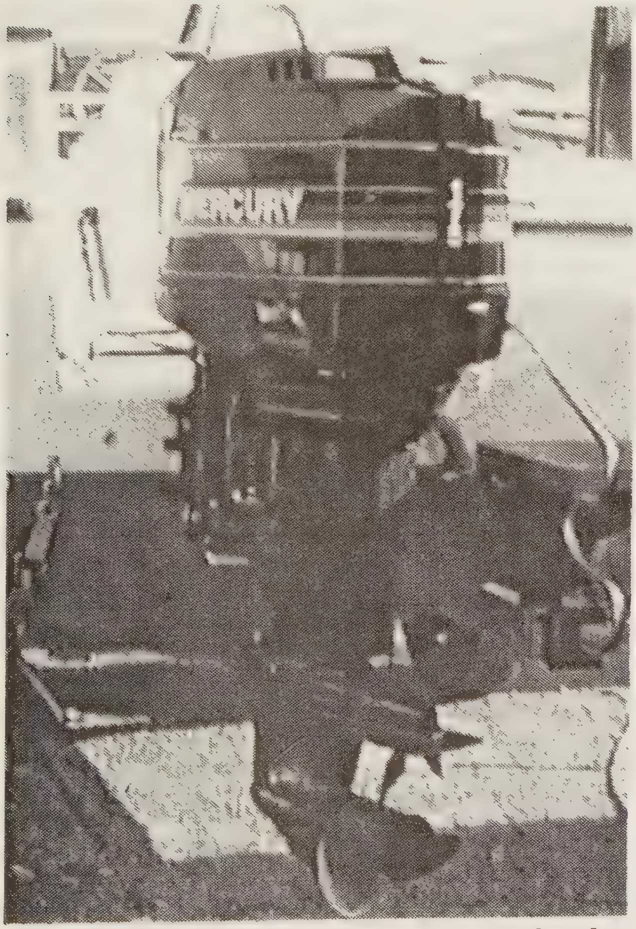
8
POWERHEAD

CHAPTER ORGANIZATION

This Chapter is divided into two working sections.

8-1 General powerhead information beginning on this page.

8-2 Complete service of a V6 powerhead for the models covered in this manual.



Mercury V6 outboard serviced, mounted, and ready to make a contribution to fun days on the water. Proper powerhead service and maintenance will ensure trouble free operation and maximum enjoyment for the owner and his/her guests.

8-1 GENERAL POWERHEAD INFORMATION

The carburetion and ignition principles of two-cycle engine operation **MUST** be understood in order to perform a proper tune-up or overhaul work on an outboard unit.

The two-cycle engine differs in several ways from a conventional four-cycle (automotive) engine. Four of the most prominent are listed.

1- The method by which the air/fuel mixture is delivered to the combustion chamber.

2- The complete lubrication system.

3- In most cases, the ignition system.

4- The frequency of the power stroke.

These differences will be discussed briefly and compared with the four-cycle engine operation.

Intake/Exhaust

Two-cycle engines utilize an arrangement of port openings to admit fuel to the combustion chamber and to purge the exhaust gases after burning has been completed. The ports are located in a precise pattern in order for them to be opened and closed at an exact moment by the piston as it moves up and down in the cylinder. The exhaust port is located slightly higher than the fuel intake port. This arrangement opens the exhaust port first as the piston starts downward and therefore, the exhaust phase begins a fraction of a second before the intake phase.

Actually, the intake and exhaust ports are spaced so closely together that both open almost simultaneously. For this reason, the pistons of most two-cycle engines have a deflector-type top (crown). This design of the piston top serves two purposes very effectively.

First, it creates turbulence when the incoming charge of fuel enters the combustion chamber. This turbulence results in more complete burning of the fuel than if the piston top were flat. The second effect of the deflector-type piston crown is to force the exhaust gases from the cylinder more rapidly.

This system of intake and exhaust is in marked contrast to individual valve arrangement employed on four-cycle engines.

Lubrication

A two-cycle engine is lubricated by mixing oil with the fuel. Therefore, various parts are lubricated as the fuel mixture passes through the crankcase and the cylinder. Four-cycle engines have a crankcase containing oil. This oil is pumped through a circulating system and returned to the crankcase to begin the routing again.

Physical Laws

The two-cycle engine is able to function because of two very simple physical laws.

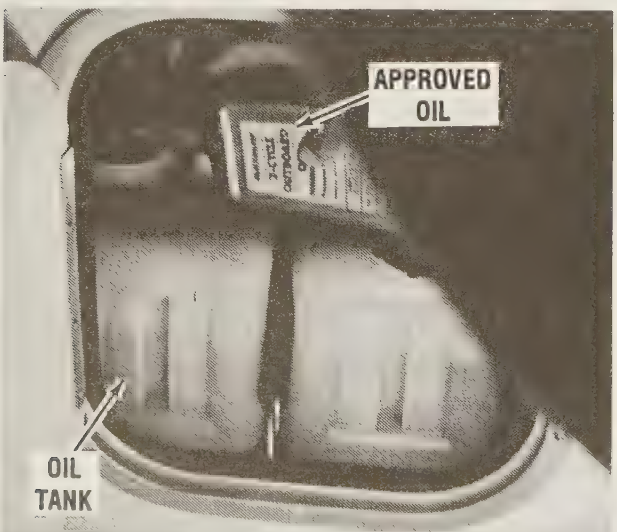
One

Gases will flow from an area of high pressure to an area of lower pressure.

A tire blowout is an example of this principle. The high-pressure air escapes rapidly if the tube is punctured.

Two

If a gas is compressed into a smaller area, the pressure increases, and if a gas expands into a larger area, the pressure is decreased.



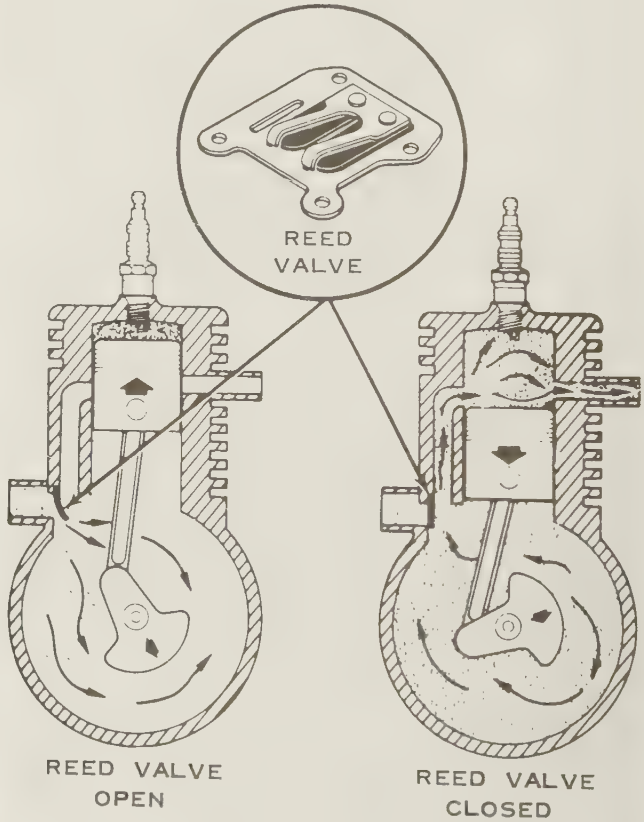
Adding approved oil to the oil tank mounted under an aft seat. The oil reservoir on the powerhead contains the low oil warning device.

If these two simple laws are kept in mind, the operation of the two-cycle engine will be easier understood.

Actual Operation

Beginning with the piston approaching top dead center on the compression stroke: The intake and exhaust ports are closed by the piston; the reed valve is open; the spark plug fires; the compressed fuel-air mixture is ignited; and the power stroke begins. The reed valve was open because as the piston moved upward, the crankcase volume increased, which reduced the crankcase pressure to less than the outside atmosphere.

As the piston moves downward on the power stroke, the combustion chamber is filled with burning gases. As the exhaust port is uncovered, the gases, which are under great pressure, escape rapidly through the exhaust ports. The piston continues its downward movement. Pressure within the crankcase increases, closing the reed valves against their seats. The crankcase then



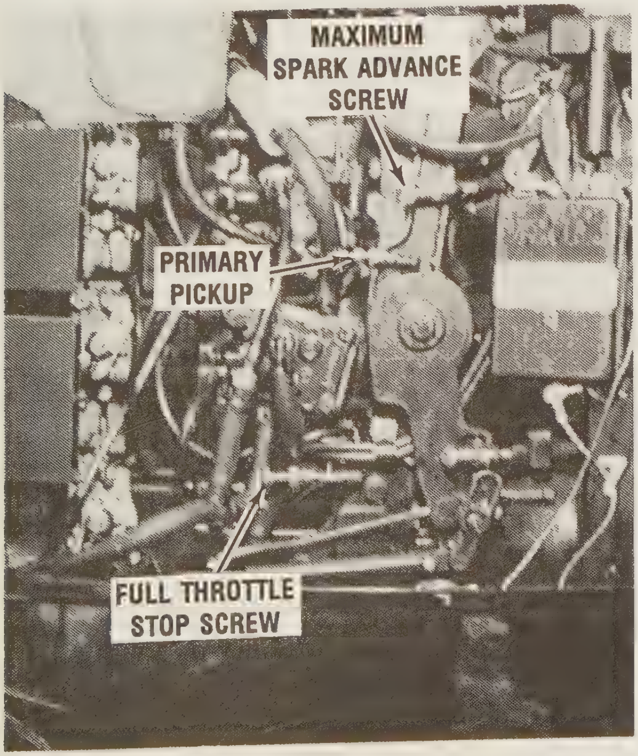
Reed valves are used to control the flow of air/fuel into the crankcase and eventually into the cylinder. As the piston moves upward in the cylinder, the resulting suction in the crankcase overcomes the spring tension of the reed. The reed is pulled free from its seat and the air/fuel mixture is drawn into the crankcase.

becomes a sealed chamber. The air/fuel mixture is compressed ready for delivery to the combustion chamber.

As the piston continues to move downward, the intake port is uncovered. A fresh air/fuel mixture rushes through the intake port into the combustion chamber striking the top of the piston where it is deflected along the cylinder wall. The reed valve remains closed until the piston moves upward again.

When the piston begins to move upward on the compression stroke, the reed valve opens because the crankcase volume has been increased, reducing crankcase pressure to less than the outside atmosphere. The intake and exhaust ports are closed and the fresh fuel charge is compressed inside the combustion chamber.

Pressure in the crankcase decreases as the piston moves upward and a fresh charge of air flows through the carburetor picking up fuel. As the piston approaches top dead center, the spark plug ignites the air/fuel mixture, the power stroke begins and one complete cycle has been completed.



Location of the maximum spark advance screw, the primary pickup, and the full throttle stop screw, mentioned in the text.

Timing

The exact time of spark plug firing depends on engine speed. At low speed the spark is retarded, fires later than when the piston is at or beyond top dead center. Engine timing is built into the unit at the factory.

At high speed, the spark is advanced, fires earlier than when the piston is at top dead center. On some late models and larger engines, the timing can be changed in the field to meet advance and retard factory specifications.

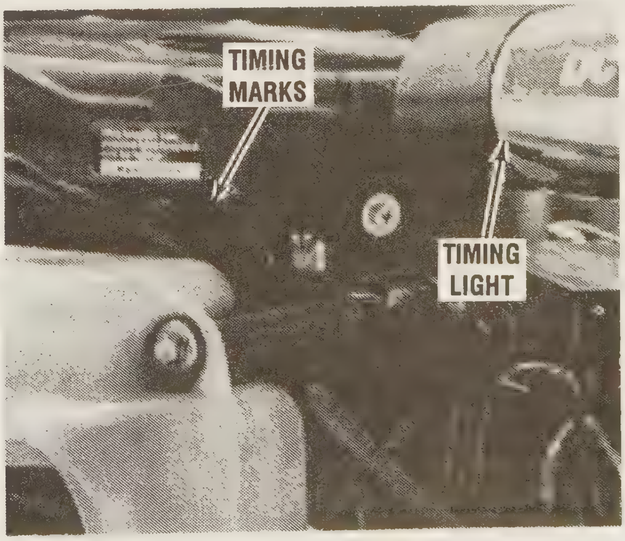
Summary

More than one phase of the cycle occurs simultaneously during operation of a two-cycle engine. On the downward stroke, power occurs above the piston while the ports are closed. When the ports open, exhaust begins and intake follows. Below the piston, fresh air/fuel mixture is compressed in the crankcase.

On the upward stroke, exhaust and intake continue as long as the ports are open. Compression begins when the ports are closed and continues until the spark plug ignites the air/fuel mixture. Below the piston, a fresh air/fuel mixture is drawn into the crankcase ready to be compressed during the next cycle.

Repair Procedures

Service and repair procedures will vary slightly between individual models, but the



Using a timing light to check or set the timing on a V6 powerhead. On a bright sunny day, an assistant making shade is usually necessary to see the light.

basic instructions are quite similar. Special tools may be called out in certain instances. These tools may be purchased from the local marine dealer.

The powerheads covered in this Chapter have some differences in construction. Two of the most prominent differences are what is termed a "loop charged" system, and the other is electronic fuel injection into the cylinder.

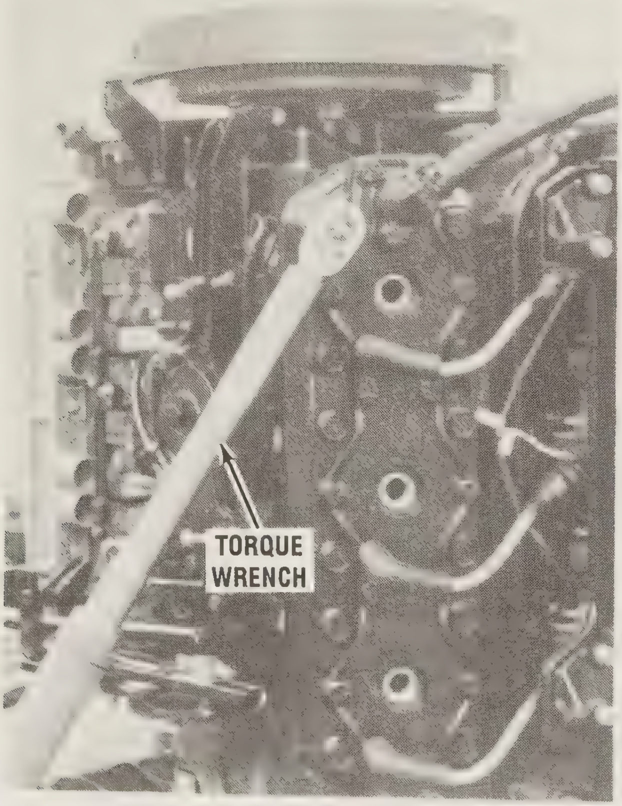
Another difference is whether caged or uncaged crankpin connecting rod bearings are used.

Torque Values

All torque values must be met when they are specified. Refer to the Specifications in the Appendix.

Powerhead Components

Service procedures for the carburetors, fuel pumps, cranking motor, and other powerhead components are given in their respective chapters of this manual. Consult the Table of Contents.



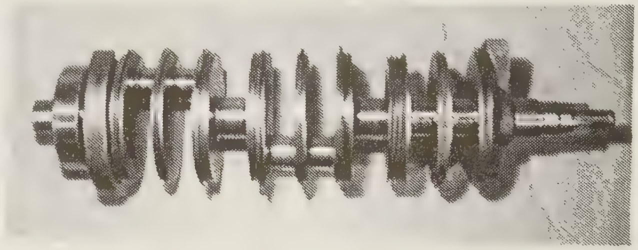
A torque wrench is an essential tool when working on any powerhead or engine. Bolts and nuts must be tightened to the required torque value.

Reed Block Installation

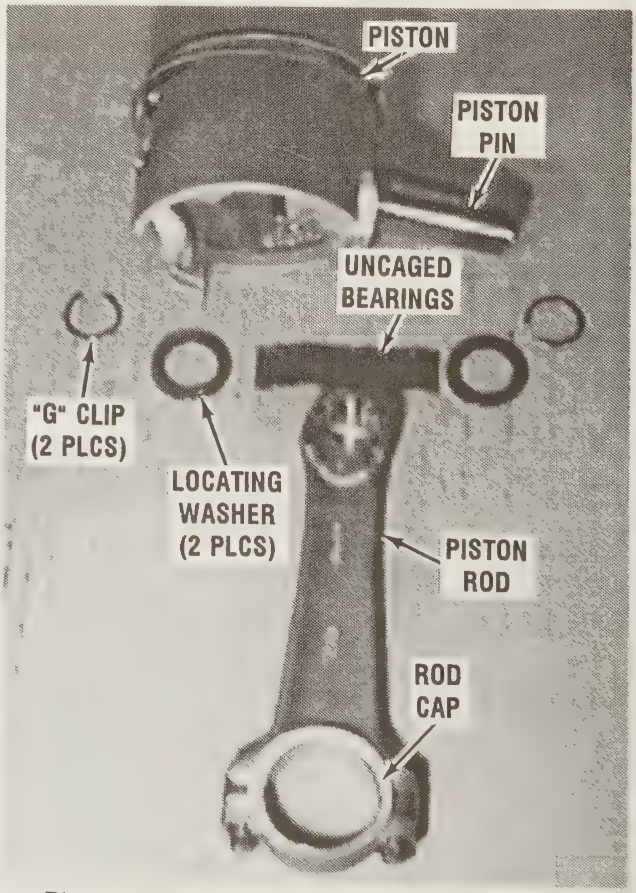
The reed block assemblies are installed under the reed block housing cover or under the carburetor. This arrangement does not require the powerhead of some models to be completely disassembled in order to replace the reeds.

Cleanliness

Make a determined effort to keep parts and the work area as clean as possible. Parts **MUST** be cleaned and thoroughly inspected before they are assembled, installed, or adjusted. Use proper lubricants, or their equivalent, whenever they are recommended.



A V6 crankshaft cleaned and ready for installation and years of service.



*Piston and rod parts laid out ready for installation. All parts **MUST** be kept together and in order to ensure they are returned to their original location.*

8-2 V6 POWERHEAD SERVICE ALL MODELS SINCE 1990

FIRST THESE WORDS

The Mercury/Mariner powerheads covered in this chapter are of the 64° and 74° V-block design. Models 135hp thru 225hp have a 60° V-block, the Model 275hp has a 74° V-block.

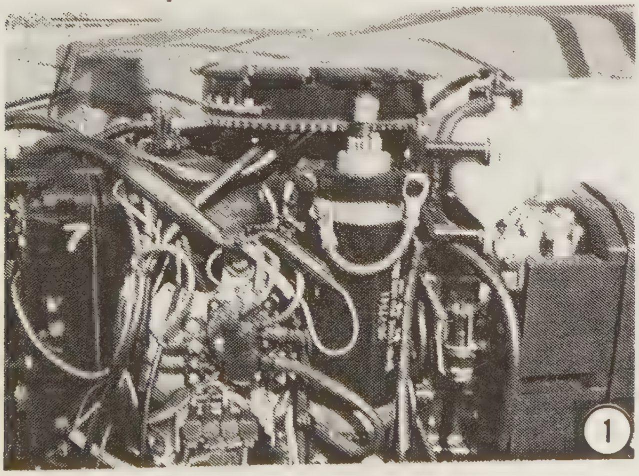
When the service procedures differ between these models, a heading will identify the 74° powerhead simply as "Units With 74° V-Block".

ADVICE

Before commencing any work on the powerhead, an understanding of two-cycle engine operation will be most helpful. Therefore, it would be well worth the time to study the principles of two-cycle engines, as outlined briefly in Section 8-1. A Polaroid, or equivalent instant-type camera is an extremely useful item, providing the means of accurately recording the arrangement of parts and wire connections **BEFORE** the disassembly work begins. Such a record is invaluable during the assembly work.

In order to obtain the maximum results from the overhaul work, the instructions outlined in this section for removal, disassembly, assembling and installation should be followed in the sequence given. If complete disassembly is not required, begin the assembling sequence at that point, after following the Cleaning and Inspecting procedures for the items disassembled. Complete disassembly of the powerhead is usually not necessary. For instance:

To inspect the cylinder walls and pistons.
Minor repairs on supporting components, such as, the ignition system, carburetors, reed blocks, and the cylinder heads.
Operational check of the thermostats and temperature sender.



1

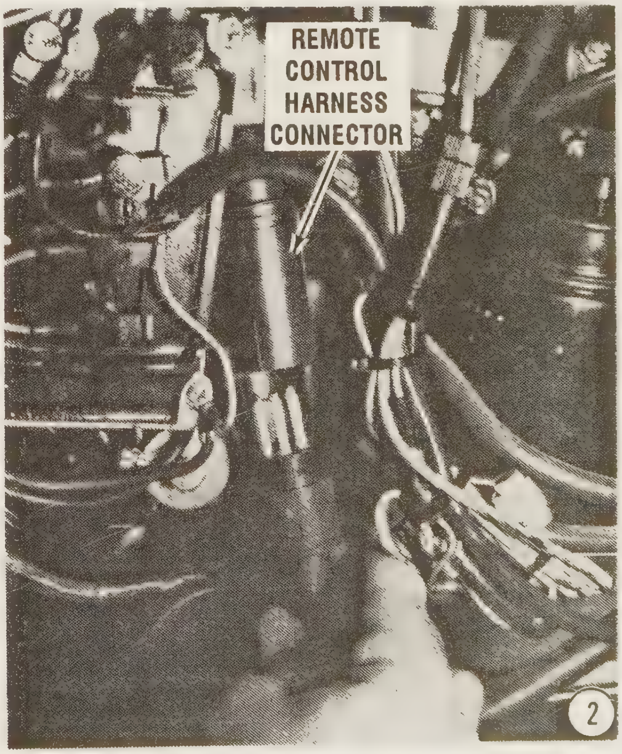
POWERHEAD REMOVAL

1- Disconnect the battery cables from the battery terminals. Disconnect the fuel supply line from the fuel tank. Unlatch and remove the top cowling or remove the front cover and swing the port and starboard cowling halves open. Lift the cowlings free of the rear support pins and set them aside.

2- If the model is equipped with a remote control harness retainer across the lower front cowling, remove the two screws and lift out the retainer. Disconnect the remote control cable harness from the side of the powerhead.

WORDS OF ADVICE

STOP! Carefully observe the wiring and hose connections before proceeding. Because there are so many different outboards and the arrangement is slightly different on each, it is not possible to illustrate all of them. Even if they were shown, the reader would not be able to identify the outboard being serviced. Therefore, **TAKE TIME** to make notes and tag the wiring and hoses. You may elect to follow the practice of many professional mechanics by taking a series of photographs of the powerhead, one from the top, and a couple from the sides showing the wiring and hose arrangements along with other parts.



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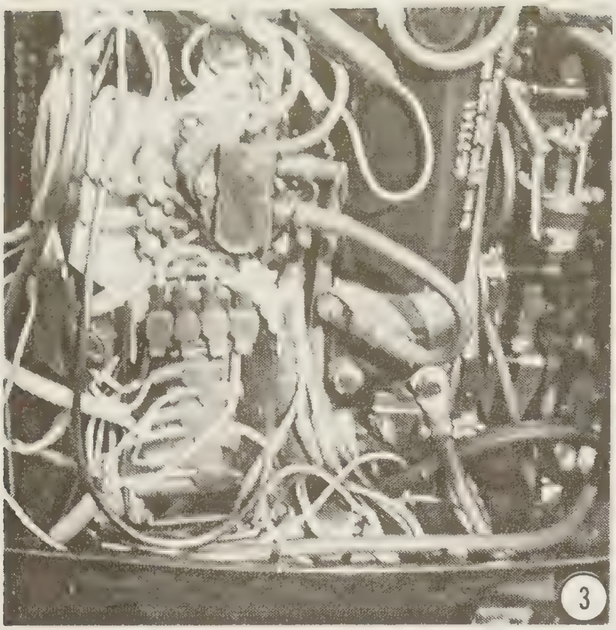
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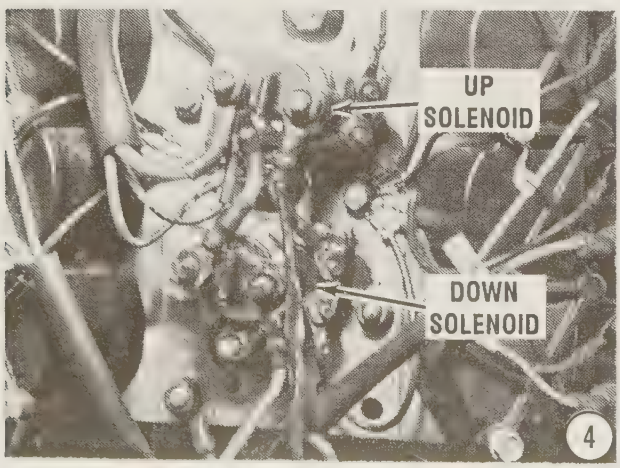
3- Disconnect the following color coded wire leads from the plug-in connectors on the starboard side of the powerhead: Trim Indicator lead - Brown/White; Trim Up lead - Blue/White; Trim Down lead - Green/White; Overheat Sensor lead - Tan; and the Trim Up/Down harness connector.

4- Disconnect the Blue, Green, and Black trim harness leads from the up solenoid and the down solenoid -- located on the aft surface of the powerhead. Release the leads from the J-clip on the exhaust cover.

Model 135 thru 225hp

5- Disconnect the throttle cable by loosening the screw on the throttle latch. Rotate the latch 45 degrees and lift the throttle cable end free of the anchor pin. Loosen the locknut on the shift cable latch assembly, and rotate the latch exposing the end of the shift cable. Lift the shift cable end free of the latch assembly



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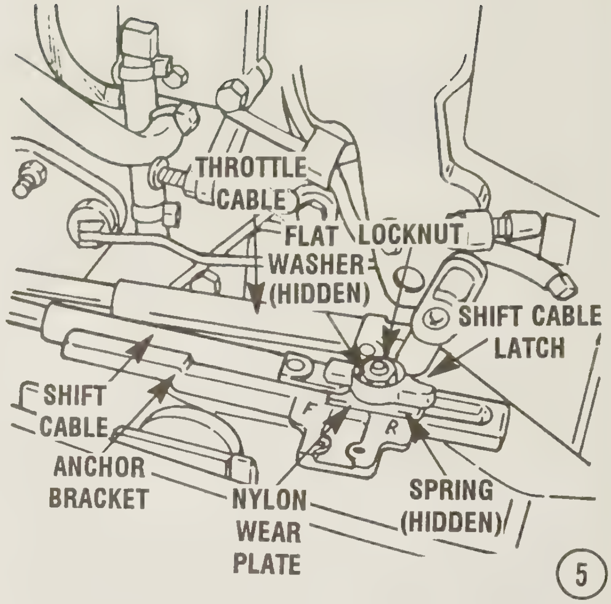


5

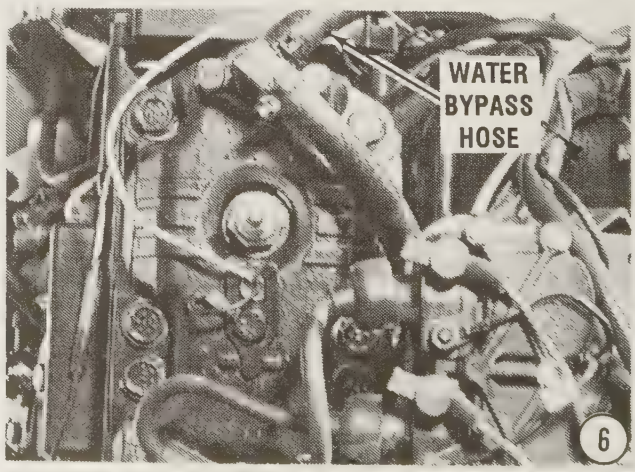
pin. Unlatch the throttle and shift cable barrel retainer, slide both the throttle and shift cable barrels from the retainer.

6- Disconnect the water hose from the tattle-tale nozzle on the lower cowling. Remove the four bolts securing the lower cowling halves together, and then lift them free of the powerhead. Disconnect the water by-pass hose from the fitting on the exhaust adapter plate below the powerhead.

7- Remove the eight nuts and lockwashers -- four on each side of the powerhead **AND** the two bolts -- one on each side -- securing the powerhead to the driveshaft housing.

Model 275hp Only

Disconnect the throttle cable by loosening the screw on the throttle latch. Rotate the latch 45 degrees and lift the throttle cable end free of the anchor pin. Remove the bolt, flat washer and locknut from the throttle cable barrel nut.



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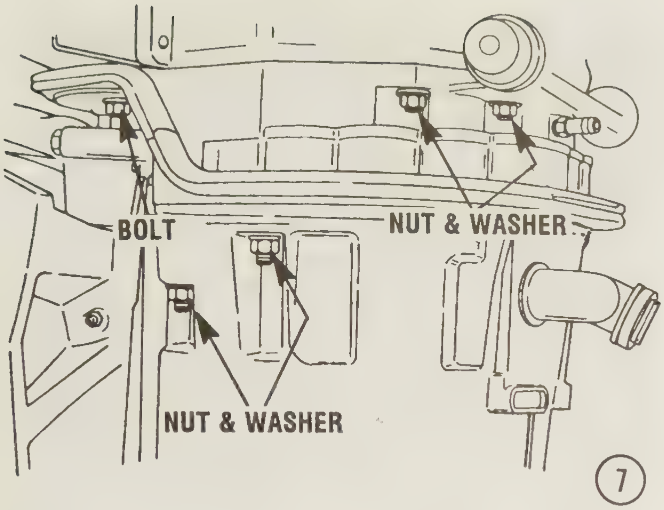
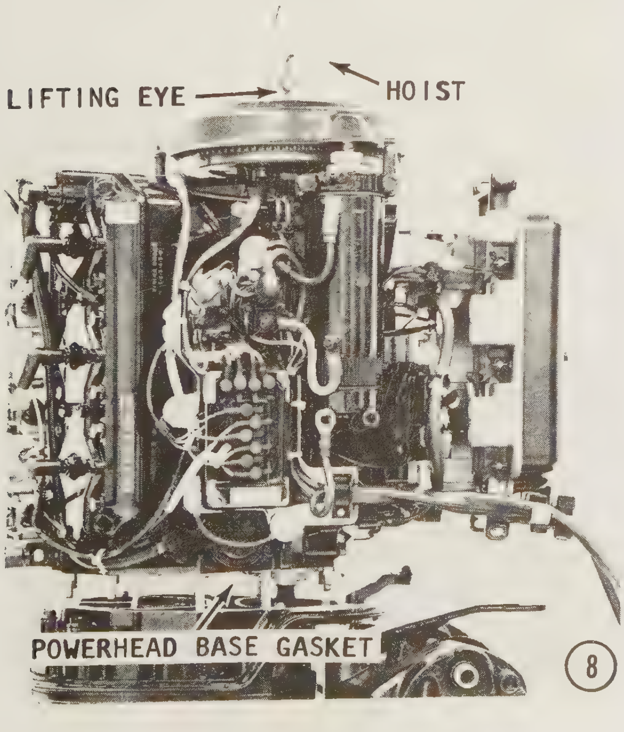


7

Slide the barrel nut free of the throttle cable bracket. Disconnect the shift cable by removing the bolt, flat washer and locknut from both the shift cable barrel nut and the end of the shift cable. Slide the barrel nut free of the anchor bracket.

Disconnect the water hose from the tattletale nozzle on the rear of the cowling support bracket. Remove the four locknuts and flat washers securing the rear cowling bracket assembly to the exhaust manifold cover, and then lift the cowling bracket assembly from the powerhead.

Disconnect the remote oil tank hose from the oil reservoir on the powerhead. If the reservoir has oil, cap the fitting to prevent oil leaking out. Disconnect the pulse oil tank hose from the check valve under the powerhead.



8

Remove the pin securing the shift arm to the shift shaft, using a hammer and punch. Tap the pin out and then lift the arm from the shift shaft.

Remove the four wing nuts securing the flywheel cover to the powerhead and lift the cover free.

Remove the six nuts and lock washers securing the powerhead to the exhaust section.

All Units

8- Remove the plastic cap from the center of the flywheel. Thread a lifting eye into the flywheel as far as possible. Using a suitable hoist, lift the powerhead assembly clear of the driveshaft housing. Remove the powerhead base gasket. The gasket may remain on the driveshaft housing.

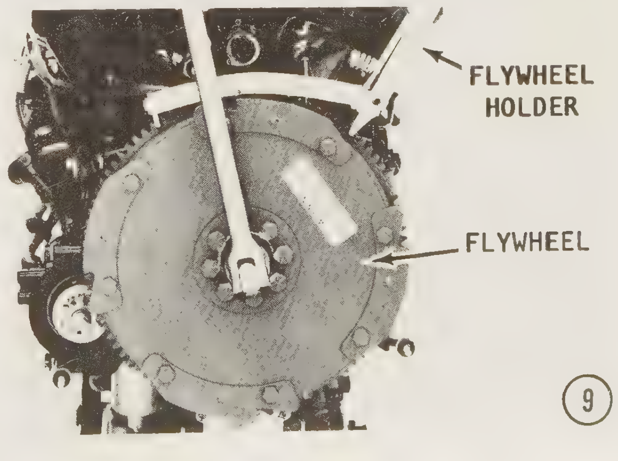
9- Mount the powerhead onto some type of stand, to facilitate easy access to all parts. **NEVER** attempt to mount the powerhead in a stand secured in a vise. Such an attempt will only lead to damage of the powerhead and possibly to personal injury. Remove the lifting eye from the crankshaft.

Disconnect the high-tension leads from the spark plugs. **ALWAYS** use a pulling and twisting motion on the "boot" as a precaution against damaging the connection. Remove the spark plugs from both heads.

Remove the flywheel cover from the powerhead. Hold the flywheel from rotaing with a strap wrench or with a Mercury Flywheel Holder P/N C-91-52344. Remove the flywheel nut and washer.

10- Remove the locknut securing the trigger link rod to the upper end of the vertical throttle lever.

11- Install a crankshaft Protector Cap, P/N C-91-24161, onto the end of the crankshaft.



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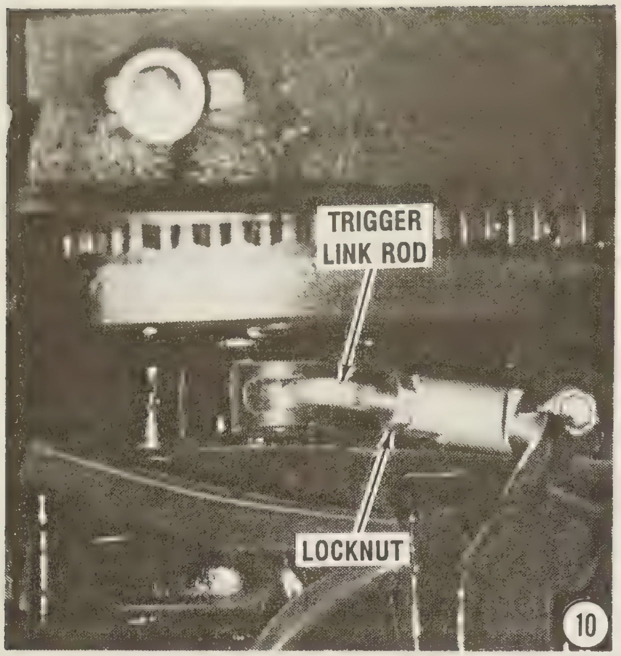


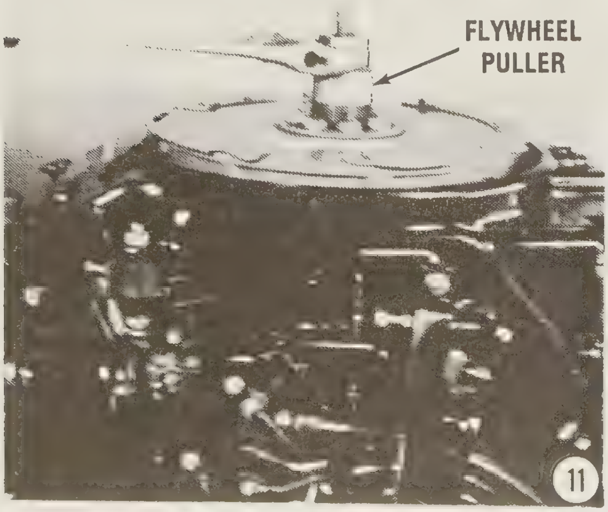
Install Flywheel Puller, P/N C-91-73687A1 into the flywheel. These two items are necessary and may be obtained from the local Mercury/Mariner dealer.

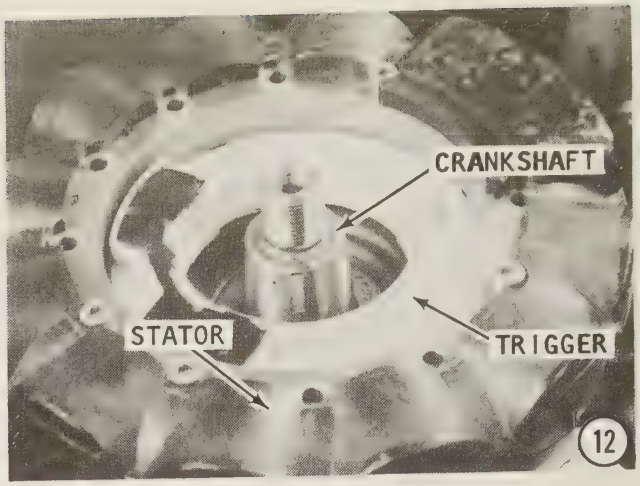
BAD NEWS

The crankshaft may very likely be damaged if the protector cap is not used between the crankshaft and the flywheel puller.

NEVER attempt to use a puller which pulls on the outside edge of the flywheel, or the flywheel may be damaged.

NEVER hammer on the end of the center bolt of the puller, because such action will surely cause damage either to the crankshaft, or the bearings, or both.





NEVER use heat as an aid to removing the flywheel. Applying heat may seize the flywheel to the crankshaft.

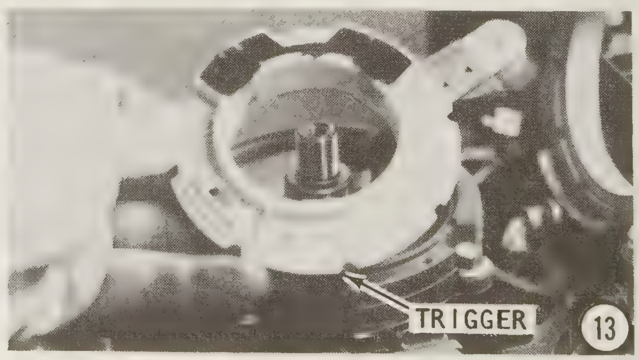
Take up on the puller until the flywheel breaks loose from the crankshaft. Remove the flywheel key from the crankshaft.

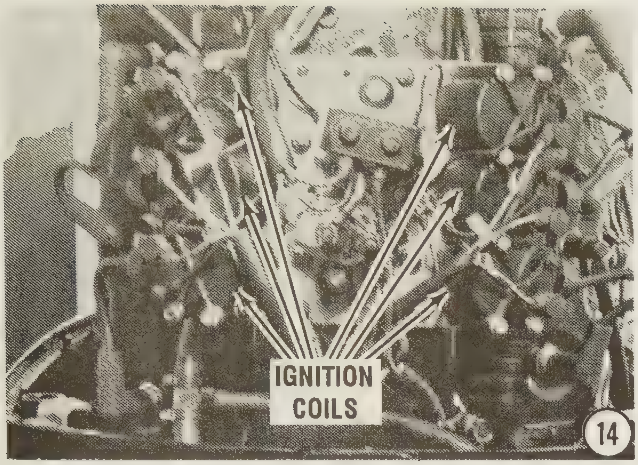
12- Disconnect the stator wires and trigger wires from the terminals of the switch boxes. Remove the stator assembly from the poweerhead. The stator assembly attaching bolts have been secured in place with Loctite, therefore, they will not back out easily.

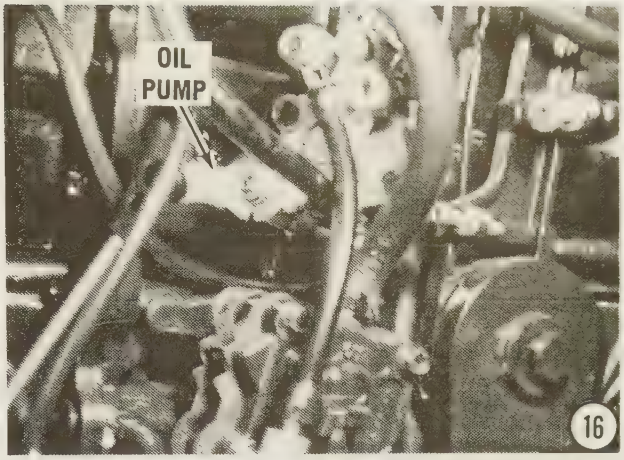
13- Remove the trigger assembly from the upper end cap. Disconnect the electrical cables from the cranking motor. Remove the upper and lower clamps securing the cranking motor to the crankcase cover. Remove the cranking motor.

SPECIAL WORDS

Because there are so many variations of the electrical equipment and components installed on the powerheads covered in this manual, it would be impractical and confusing to the reader to describe all the individual steps necessary to remove this equipment. Therefore, using







the wiring diagrams in the Appendix, locate the terminal blocks on the powerhead and disconnect all the electrical leads to the electrical components. Once again, if pictures or drawings are made prior to removal, it will make the assembly tasks much easier. Plan ahead! Some combinations of components may be removed together, without disconnecting several wires. Remove the electrical components from the powerhead and set them aside on the work bench -- preferably starboard (right), or port (left) -- the same orientation when removed from the powerhead.

14- Remove the screws securing the secondary ignition coil covers and the ignition coils to the exhaust manifold cover. Remove the coil assemblies from the powerhead. The screw threads were coated with Loctite during the previous assembling work. Therefore, they will not back out easily.

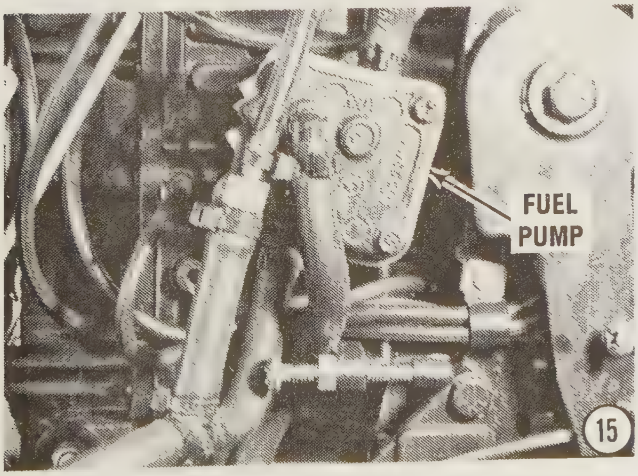
Remove the three bolts securing the ignition plate to the cylinder block. Lift the ignition plate, together with the electrical components, from the cylinder block.

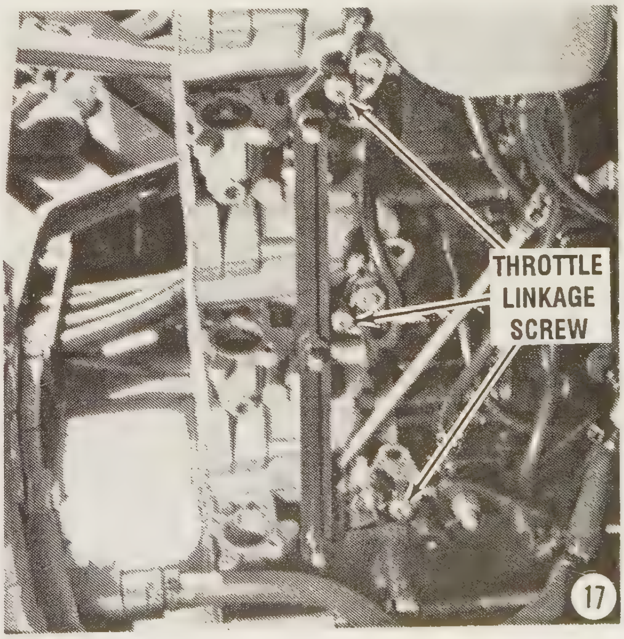
Remove the locknut, and then the throttle cam and bushings from the reed block housing stud. Remove the pivot bolt, and then lift the vertical throttle lever from the cylinder block. **REMEMBER**, a flat washer is installed between the vertical throttle lever and the cylinder block.

Remove the three bolts securing the throttle and shift control cable anchor bracket to the crankcase cover, and then remove the anchor bracket.

15- Disconnect the fuel inlet line (if not previously done), the fuel outlet line to the carburetor, and the pulse line to the crankcase from the fittings on the fuel pump. Remove **ONLY** the two screws with the slot in the head from the fuel pump. Removal of the two standard hex bolts will disassemble the fuel pump. Lift the fuel pump and gasket free of the crankcase.

16- Disconnect the inlet and outlet hose from the oil pump. Plug the end of the hoses to prevent foreign matter from entering. Unsnap the link rod from the link arm on the oil



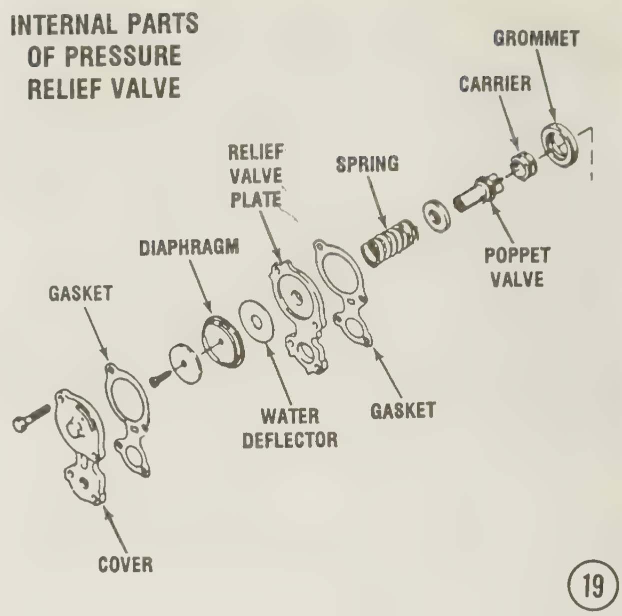


pump. Remove the two retaining bolts from the oil pump. Lift the oil pump clear of the powerhead. Remove the **O**-ring from around the bushing. Reach into the block with a pair of needle nose pliers and withdraw the coupler. **TAKE CARE** not to lose the small plug and the magnet from the recess in the coupler. Reach in again with the needle nose pliers, and grasp the oil pump shaft. Pull and rotate the shaft slightly **CLOCKWISE** to withdraw the shaft.

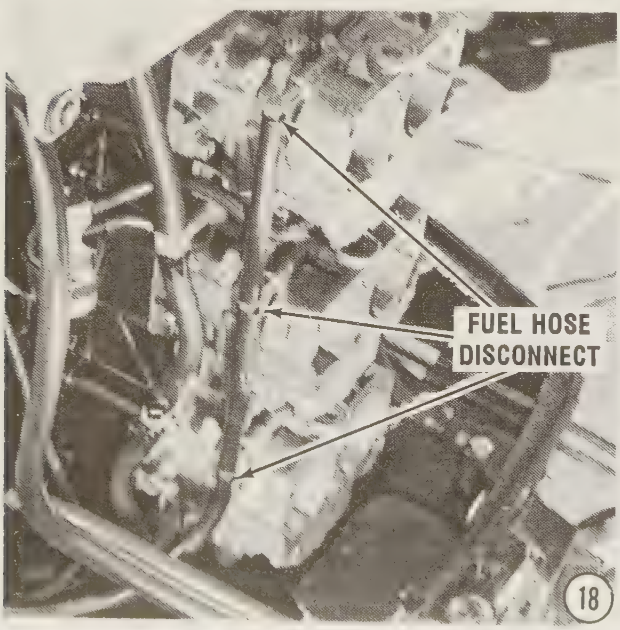
17- Remove the two bolts attaching the air box cover to the air silencer, and then lift the cover free. Remove the six bolts attaching the air silencer to the carburetors. Slide the silencer forward and disconnect the bleed hose. Remove the three screws on the throttle linkage, one at each carburetor. Slide the linkage free of each carburetor shaft and remove the linkage as an assembly from the powerhead.

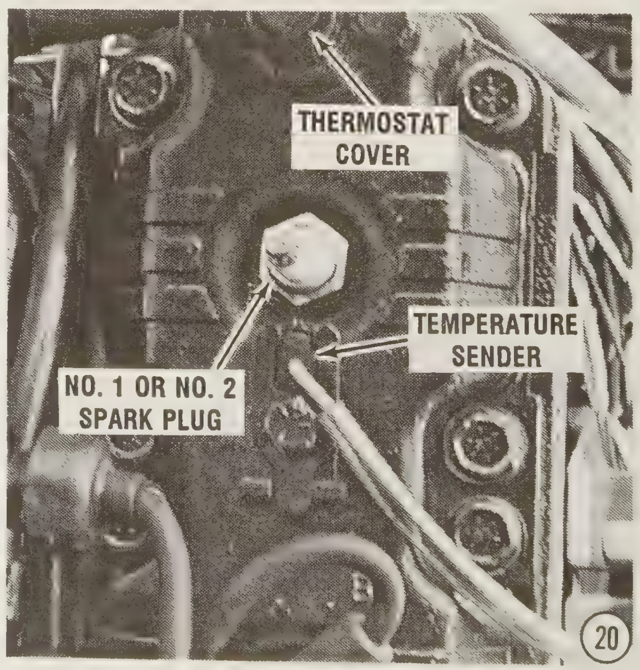
18- Disconnect the fuel hoses from the top, middle and bottom carburetors. Place a tag on each carburetor to identify from which position it was removed. The carburetors **MUST** be installed back in their original position. Loosen and remove the four nuts securing each carburetor to the intake manifold. Slide each carburetor off the studs and disconnect the fuel enrichment hose.

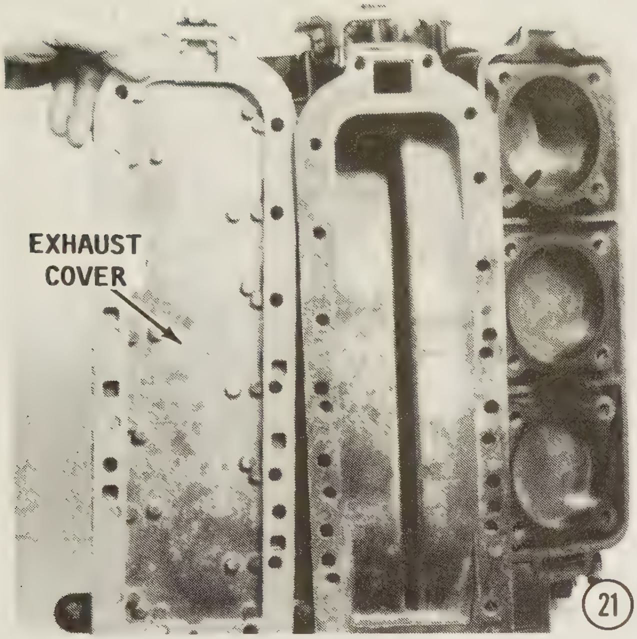
19- Disconnect the water distribution hose from the pressure relief valve cover fitting. The pressure relief valve is secured in the block with two bolts. After the bolts are removed, the entire assembly may be withdrawn from the block. The accompanying exploded drawing illustrates the order of parts. Remove the bolts securing the thermostat covers to the cylinder head. Remove the thermostat cover and the thermostat from each cylinder head.



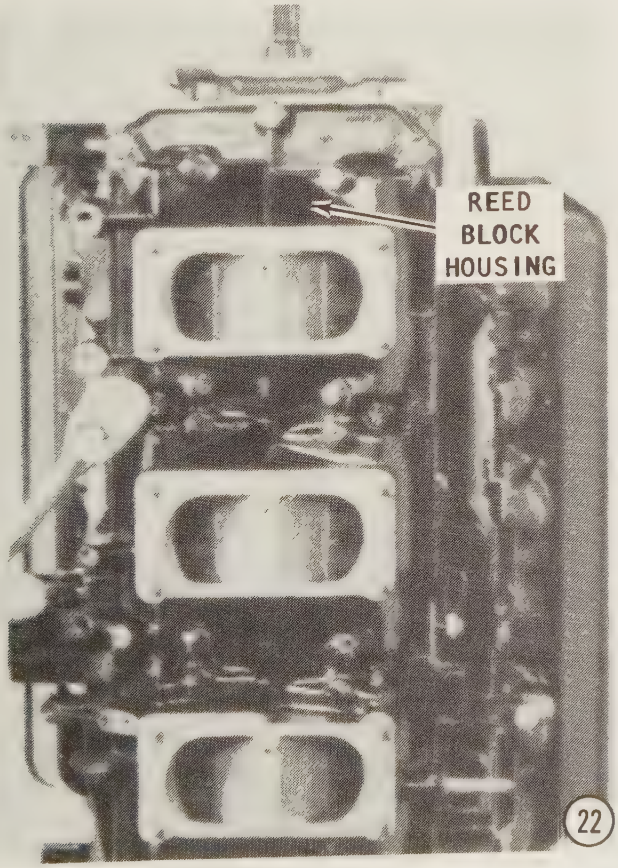
20- As an aid during assembly, observe and identify, the location of the "J" clips on the cylinder head bolts. Remove the head bolts from both heads. Remove the heads and head gaskets from the block. Remove the temperature sender from the starboard side cylinder head. As an aid to assembly, mark the location of the wiring harness support plate on the exhaust manifold cover bolt.

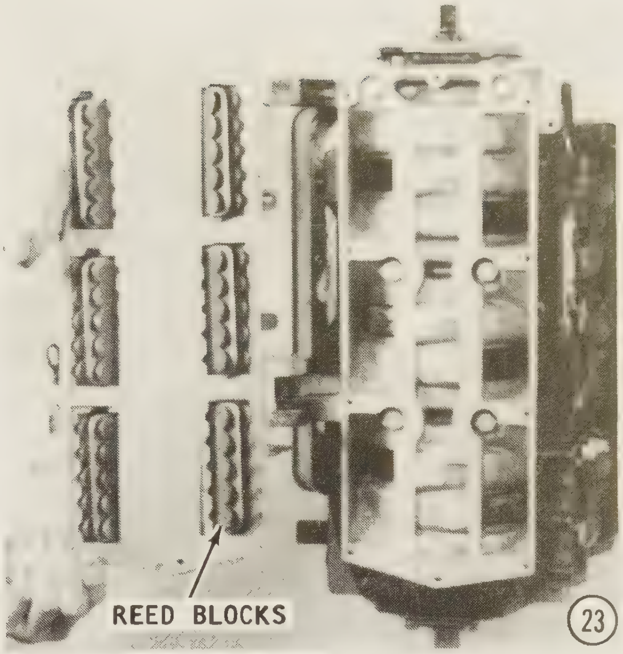






21- Remove the bolts from the exhaust manifold cover. One of the bolts also secures a wiring harness support plate assembly. Make an identification mark on the cover to indicate this bolt as an aid during assembling. Remove the exhaust manifold cover, exhaust divider plate, and the divider plate seal from the cylinder block. Inspect the divider plate for small pin holes or rust. Water in a cylinder could be caused by a defective plate or gasket.





22- Disconnect the bleed hoses from the fittings on the side of the cylinder block. One bleed hose is connected from the reed block housing to each cylinder.

REED BLOCK WORDS

Two styles of reed blocks are used on the V-6 powerheads covered in this manual. Some models use carburetors and have horizontal reed blocks. Other models are equipped with fuel injection and use vertical reed blocks.

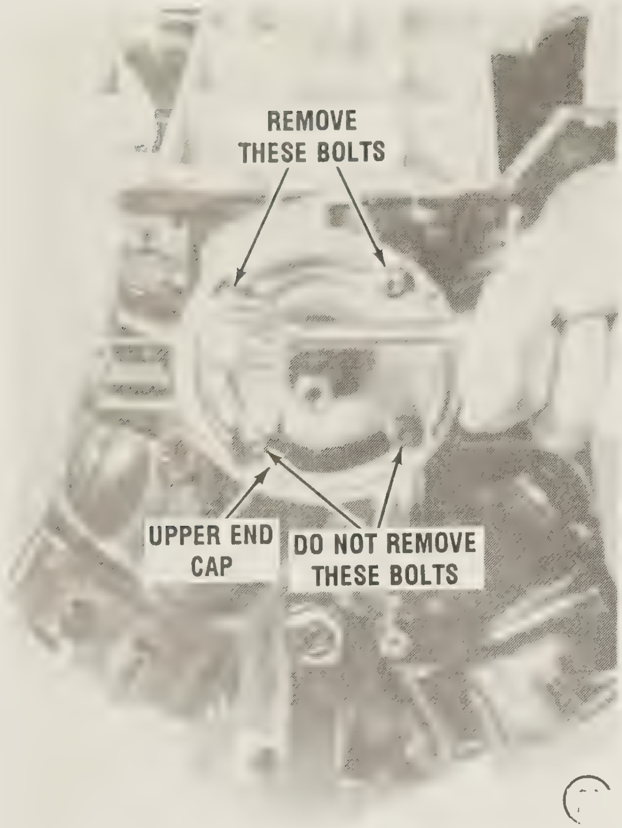
When preparing to remove the reed block housing from the powerhead, **BE SURE** to identify and remove the correct bolts for the reed block housing. Models with horizontal mounted reeds use cap screws to secure the reed blocks to the housing. Vertically mounted reed blocks are secured to the cover with bolts set at a 35^0 angle.

GOOD WORDS

It is not necessary to remove the bleed hoses from the fittings on the reed block housing.

LOOSEN, but do not remove the bolts securing the reed blocks to the housing. These bolts are located directly above and below the carburetor mounting flanges. Remove the bolts securing the reed block housing to the crank-case cover.

23- Remove the housing and the reed blocks as an assembly. Remove the bolts secur-



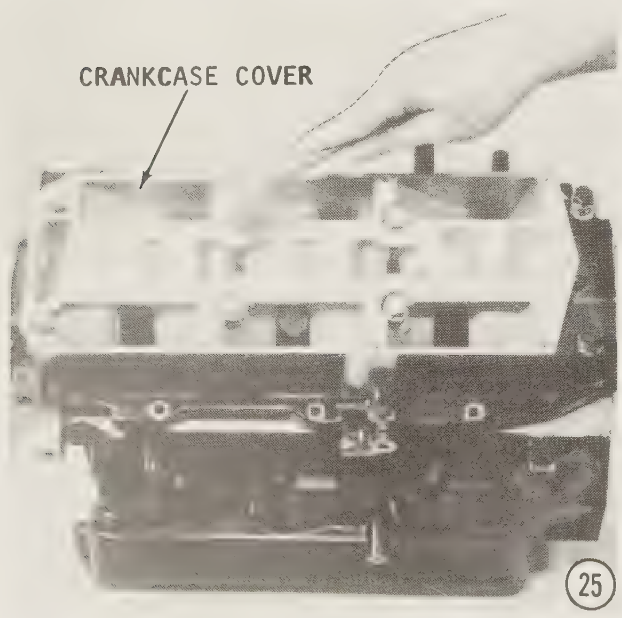
ing the reed blocks to the housing, and then remove the reed blocks.

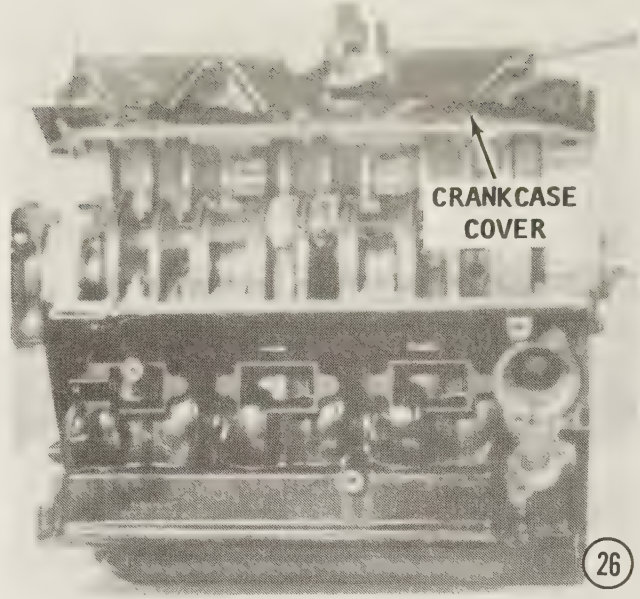
Units With 74° Block

Remove the exhaust plate.

MORE GOOD WORDS

It is not necessary to disassemble the reed blocks in order to inspect them. If inspection indicates replacement of a reed block part is





required, see the Cleaning and Inspection section in this Chapter.

24- **LOOSEN** the upper and lower attaching bolts, but **DO NOT** remove the two bolts attaching the end caps to the cylinder block.

EXPLANATION

The end cap bolts are threaded into the cylinder block. These bolts should **NOT** be removed at this time in order to hold the crankshaft in position until the connecting rods are removed from the crankshaft.

25- Remove the bolts securing the crankcase cover to the cylinder block, and then remove the crankcase cover. **TAKE CARE** not to damage the sealing surfaces or the crankshaft. A sealant is used between the cylinder block and the crankcase cover.

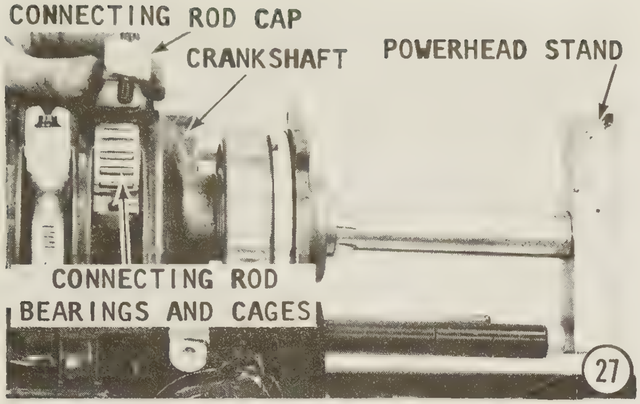
26- Pry the crankcase cover off the cylinder block, if necessary. Use **ONLY** the special recesses provided. **NEVER** pry in any other area or the sealing surfaces may be damaged. A damaged surface will not provide the necessary seal.

CRITICAL WORDS

The crankcase cover and the cylinder block are a matched, line bored assembly. Therefore, they should **ALWAYS** be kept as a matched set and **NEVER** interchanged with another block or cover.

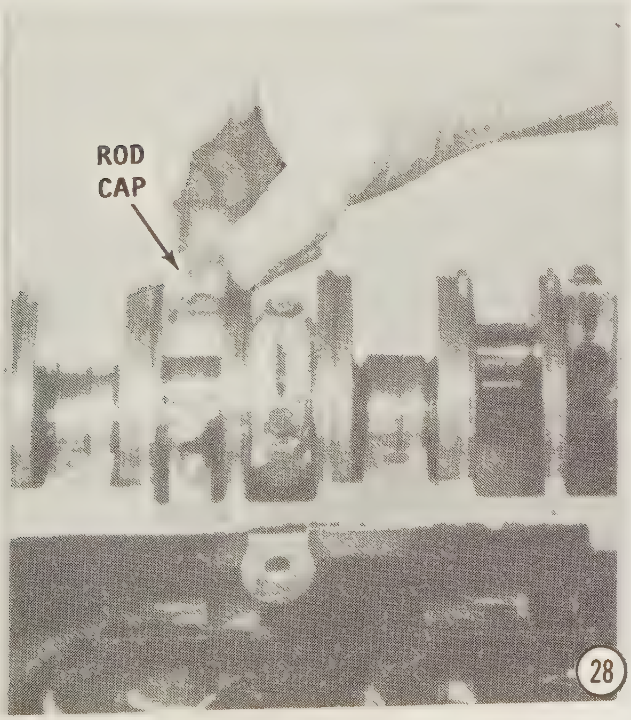
CRANKSHAFT DISASSEMBLING

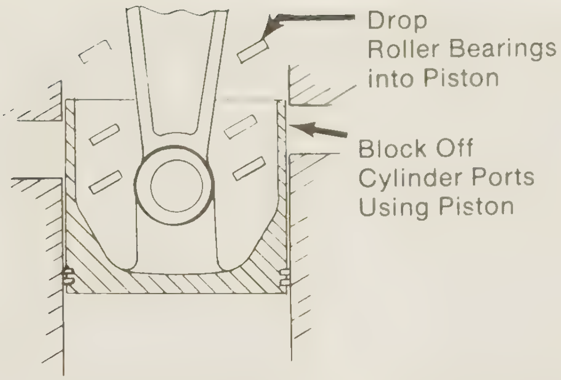
27- Install Powerhead Stand, P/N C-91-30591A1, into the driveshaft end of the crank-



shaft. Use the Powerhead Stand to turn the crankshaft to the desired positions when removing connecting rods from the crankshaft. If a powerhead stand is not available, lay the block on a workbench. Insert the flywheel key into the keyway of the crankshaft, and then slide the flywheel onto the crankshaft with the keyway in the flywheel indexed with the key. Use the flywheel to turn the crankshaft to the required location during removal of the connecting rods.

TAKE TIME to scribe an identification mark with an awl on the outside edge of each rod "I" beam and a matching mark on the inside of the piston skirt. The identification mark must match the cylinder from which the piston and rod were removed. From the top of the engine, the cylinders are numbered 1, 3, 5 on the **STARBOARD** bank, and 2, 4, 6 on the **PORT** bank.





To prevent the connecting rod roller bearings from falling into cylinder ports, first raise the piston to block the ports, then use the inverted piston to catch and hold the bearings as they are removed.

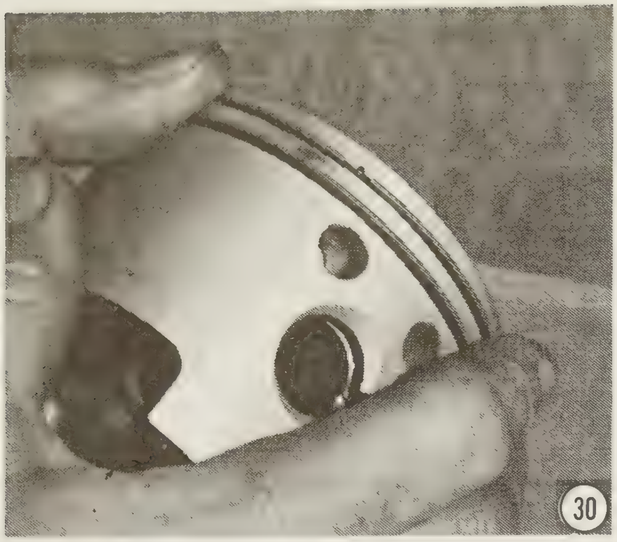
28- Remove the connecting rod cap bolts with a 5/16" 12-point socket, and then lift the rod cap, connecting rod bearings and cages from the connecting rod and crankshaft. Raise the piston upward into the cylinder to block off the ports. This maneuver will prevent the roller bearings from being lost inside the powerhead.

Repeat the procedure for each piston.

29- IMMEDIATELY after removing the piston and rod assembly, temporarily assemble the rod cap back onto the rod to keep it as a matched set. Identify and keep the rod bearings and cages together with the rod and piston assembly.

WORDS FROM EXPERIENCE

CLEANLINESS is the password, when handling roller bearings. Take extra care to prevent any dirt, lint, or other contamination from getting onto the bearings or in the cages. If the bearings are to be used again, store them in a numbered container to ensure they will be installed with the same rod and rod cap from which they were removed. **NEVER** intermix roller bearings from one rod to another. **NEVER** intermix used roller bearings with new bearings. If just one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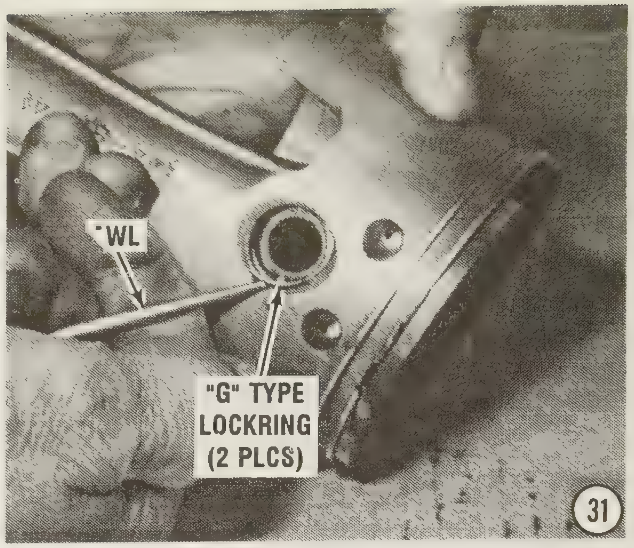


31

bearing is unfit for service, the entire set **MUST** be replaced. Handle the piston with care, because the skirt can be easily bent out-of-round if handled roughly.

Continue removing the rod caps, bearings, and piston assemblies until all have been removed from the crankshaft and the cylinder bores.

30- Remove and **DISCARD** the rings, as each piston and rod assembly is removed. Use a Piston Ring Expander, C-91-24697, to remove the rings. If this special tool is not available, remove them with your hands. After the rings have been removed from all of the pistons, carefully inspect each piston and rod assembly according to the procedures outlined in the Cleaning and Inspecting section at the end of this chapter.

PISTON DISASSEMBLING

SAFETY WORDS

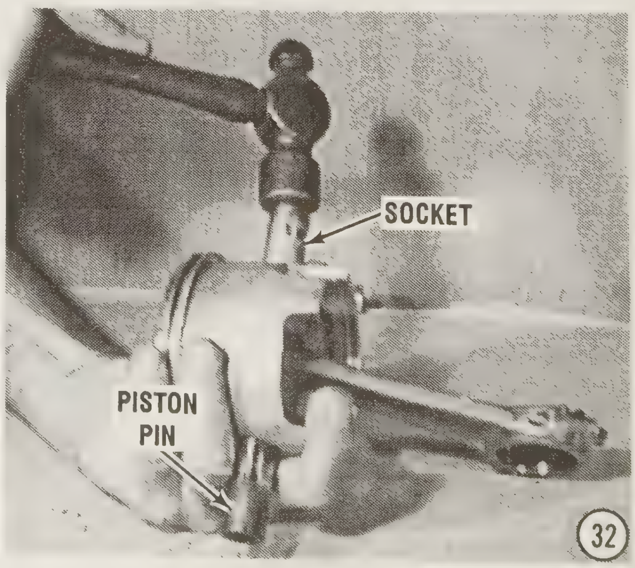
WEAR eye protection safety glasses while removing the piston pin lockrings. The lockring is made of spring steel and may slip out of the pliers or pop out of the groove with considerable force. Consider other individuals in the area.

31- Remove the two G-type lockrings using a pair of needle-nose pliers or an awl. A lockring tool, Mercury P/N 91-52952A1, may be used to remove the lockrings. Slip the awl under one edge of the lockrings; pry outward; grasp the lockring with a pair of pliers; and then pull the lockring from the groove in the piston. **TAKE CARE** not to damage the piston. **DISCARD** the lockrings. A lockring should **NEVER** be used a second time. Once removed, it loses some of its locking ability.

32- Heat the piston dome to approximately 190°F by submerging the piston in hot water or by heating the piston with a heat lamp.

The piston pin may be driven or pressed out of the piston. If the pin is to be pressed out, three tools are required. An arbor press, a Piston Support Block, P/N 91-74607A1, and a Piston Pin tool P/N 91-76159A1. Position the piston and rod assembly on the support block with either end of the pin facing up. Place the pin tool over the pin and lower the arbor press down onto the pin tool. Press the pin tool down through the piston, driving the piston pin out the opposite end.

An alternate method is to obtain a pin or deep socket, slightly smaller in diameter than the piston pin. Place the socket or pin flush against the piston pin. While holding the piston tightly in one hand, tap the socket or pin with



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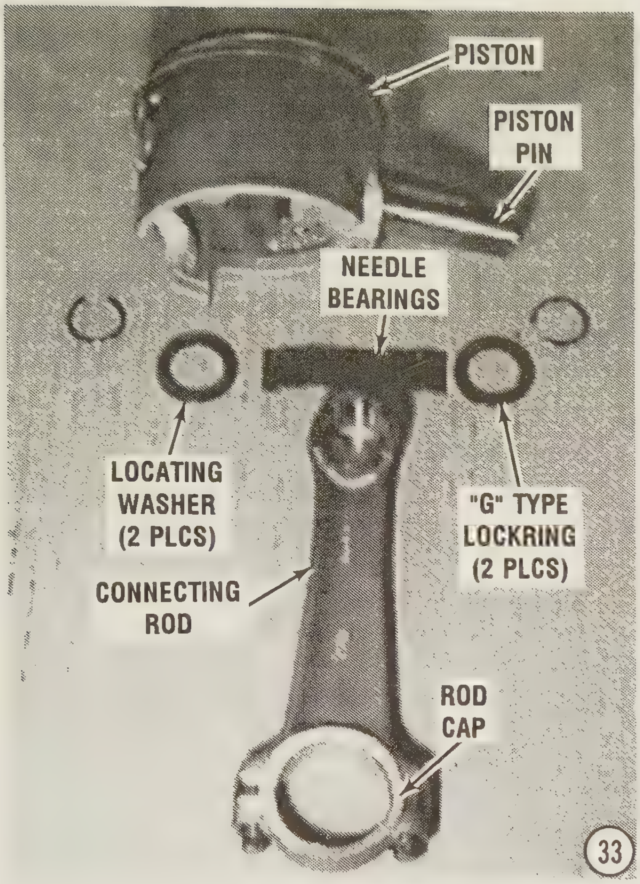


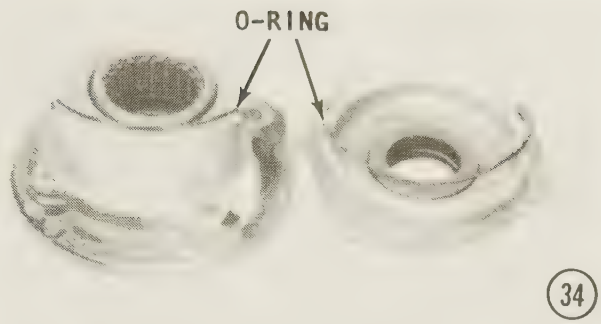
a soft faced mallet and drive the piston pin out the opposite side.

33- Remove the piston pin tool or deep socket from the piston slowly. When the tool or socket is removed from the piston be prepared to catch the loose needle bearings and two locating washers.

If the connecting rod is to be used again, save the needle bearings -- 29 by count for a 60° block -- 34 by count for a 74° block -- plus two locating washers.

CLEANLINESS

Cleanliness is the password, when handling needle bearings. Take extra care to prevent dirt, lint, or other contamination from getting onto the bearings or into the cages. If the bearings are to be used again, store them in a numbered container to **ENSURE** they will be installed with the same rod and rod cap from which they were removed. **NEVER** intermix roller bearings from one rod to another. **NEVER** intermix used roller bearings with new bearings. If just one bearing is unfit for service, the entire set **MUST** be replaced. Handle the piston with care, because the skirt can be easily bent out-of-round if it is handled roughly.



End Cap Disassembling

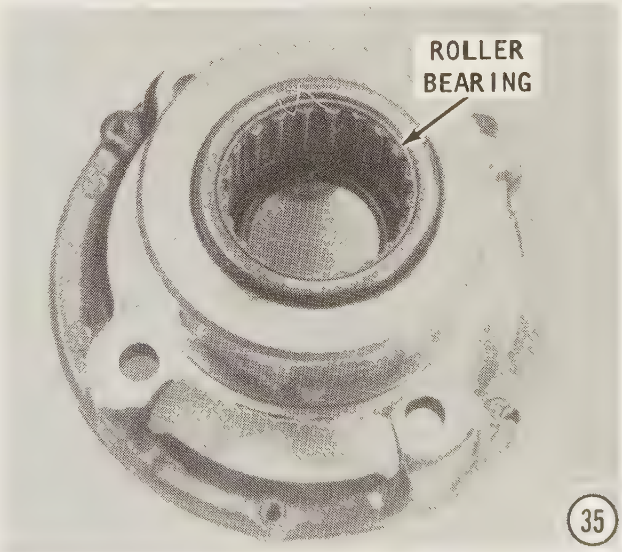
34- Remove the bolts securing the upper and lower end caps to the cylinder block. These bolts were loosened earlier to permit removal of the crankcase cover. Remove the upper and lower end caps from around the crankshaft. Remove and **DISCARD** the **O**-ring from each end cap.

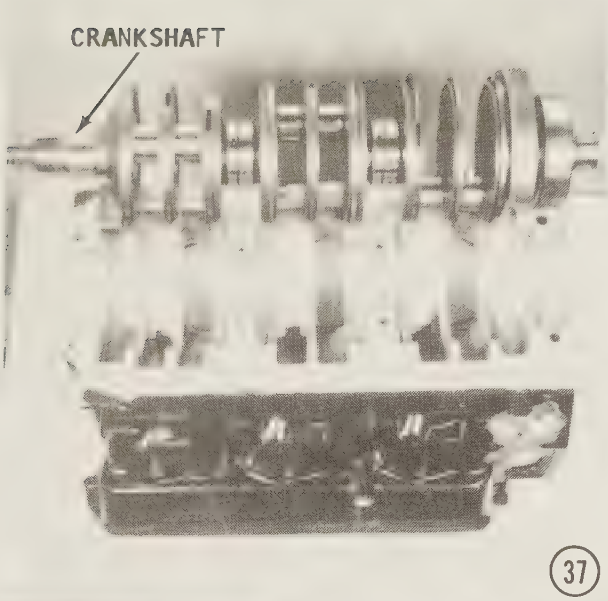
35- Inspect the roller bearing installed in the upper end cap, as outlined in the Cleaning and Inspecting section beginning on Page 8-17. **DO NOT** remove the roller bearing from the upper end cap. If the bearing is unfit for further service, replace the bearing and upper end cap as an assembly.

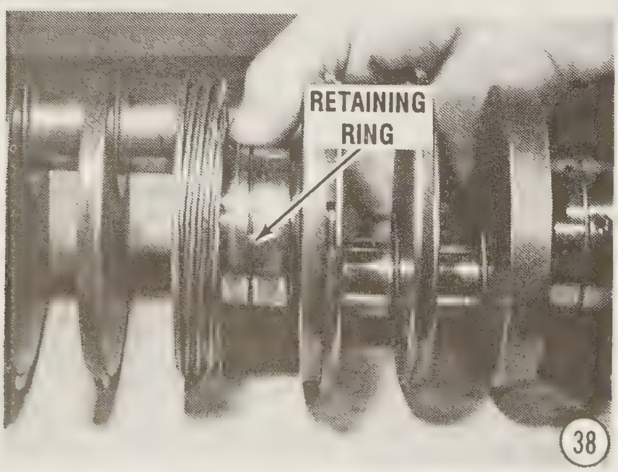
36- Remove the seal from the upper and lower end caps, with a punch, as shown.

37- Lift the crankshaft assembly from the cylinder block. **DO NOT** remove the crankshaft sealing rings from the crankshaft, unless the sealing ring/s are unfit for service and new ring/s have been obtained and are to be installed. The sealing rings usually do not require replacement **UNLESS** they are broken.

CLEANLINESS is the password when handling roller bearings. Take the same precau-





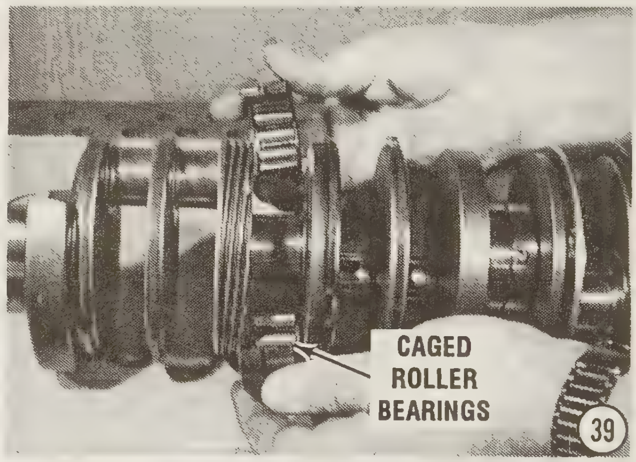


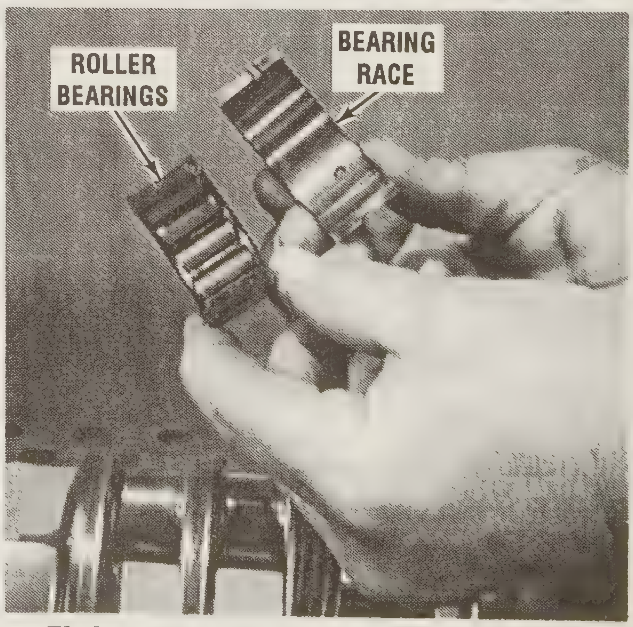
tions as stated following Step 33 for needle bearings. **NEVER** intermix roller bearings from the upper crankshaft main bearing with those from the lower main bearing.

38- Work the pointed end of an awl under the retaining ring of the upper crankshaft main bearing, and then pop the ring out.

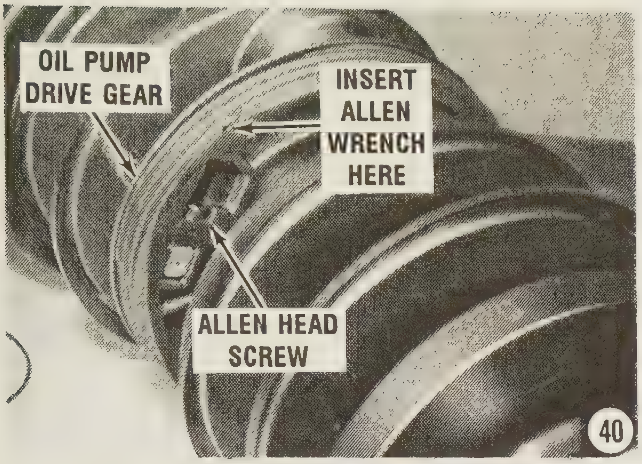
39- Remove the two bearing race halves and the roller bearings from the crankshaft. **TAKE CARE** not to distort the retaining ring during removal. The bearing race halves are matched sets and **MUST** be kept together. Therefore, **IMMEDIATELY** after removal, assemble the two bearing halves and hold them together with the retaining ring. Identify the race and keep the roller bearings with it to **ENSURE** proper installation during the assembling work.

Perform Steps 37 and 38 for the lower main bearing race.





*The bearings and their respective races **MUST** be kept together as a matched set. **NEVER** mix bearings or races.*



OIL INJECTION PUMP DRIVE GEAR WORDS

Outboard models covered in this manual may have a one piece or a two piece oil pump drive gear. Unless the oil pump drive gear teeth are damaged, or the gear is broken, **DO NOT** remove the gear from the crankshaft. The gear becomes brittle after use and any attempt to remove it will damage or break the gear.

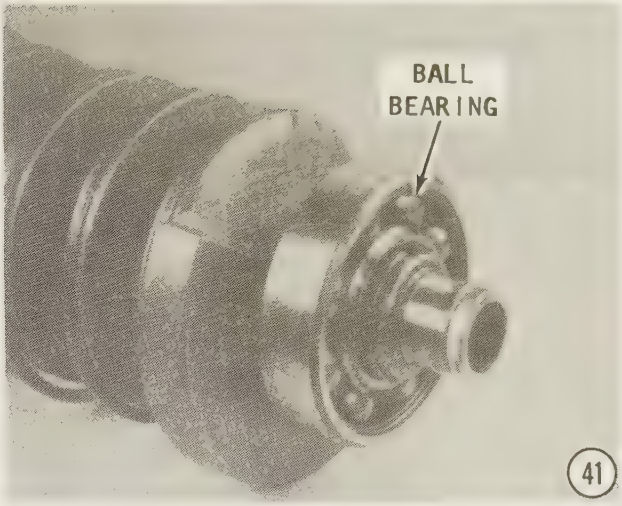
40- If the oil injection pump drive gear is unfit for service and **MUST** be replaced, remove the single Allen screw from the drive gear on one piece units. Extract the metal barrel from the drive gear. **CAREFULLY** spread the two ends of the gear apart enough to clear the crankshaft journal. **DO NOT** spread the gear any more than absolutely necessary.

If the model is equipped with a two piece gear, then remove the two Allen screws from each side of the gear. Separate the two piece gear from the crankshaft and lift off the two halves.

41- Inspect the crankshaft ball bearing installed on the lower end of the crankshaft, as outlined in the Cleaning and Inspecting section beginning on this page. **DO NOT** remove the lower crankshaft ball bearing unless it is unfit for service and it is to be replaced.

42- If the bearing is to be replaced, remove the retaining ring with a suitable pair of expanding type snap ring pliers.

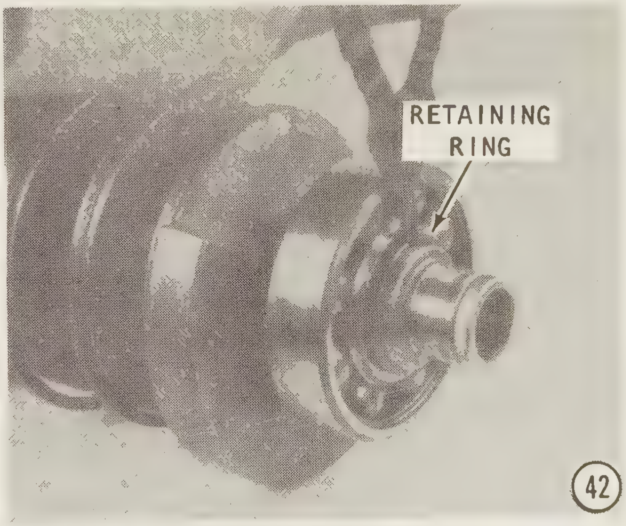
43- Install Universal Puller Plate, P/N C-91-37241, between the crankshaft ball bearing and the crankshaft counterweight. Position the crankshaft assembly in an arbor press or attach a puller tool to the plate. The crankshaft will be supported by the puller plate. Place a metal plate over the end of the crankshaft, and then press the crankshaft out of the bearing. **TAKE**

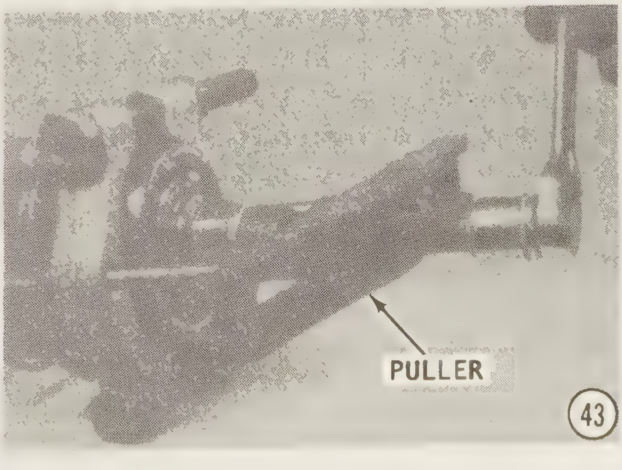


CARE to prevent the crankshaft from falling to the floor and being damaged when it clears the bearing.

CLEANING AND INSPECTING

The success of the overhaul work is largely dependent on how well the cleaning and inspecting procedures are completed. If





some parts are not thoroughly cleaned, or if an unsatisfactory unit is allowed to be returned to service through negligent inspection, the time and expense involved in the work will not be justified with peak engine performance and long operating life. Therefore, the procedures in the following sections should be followed in detail and the work performed with patience and attention to detail.

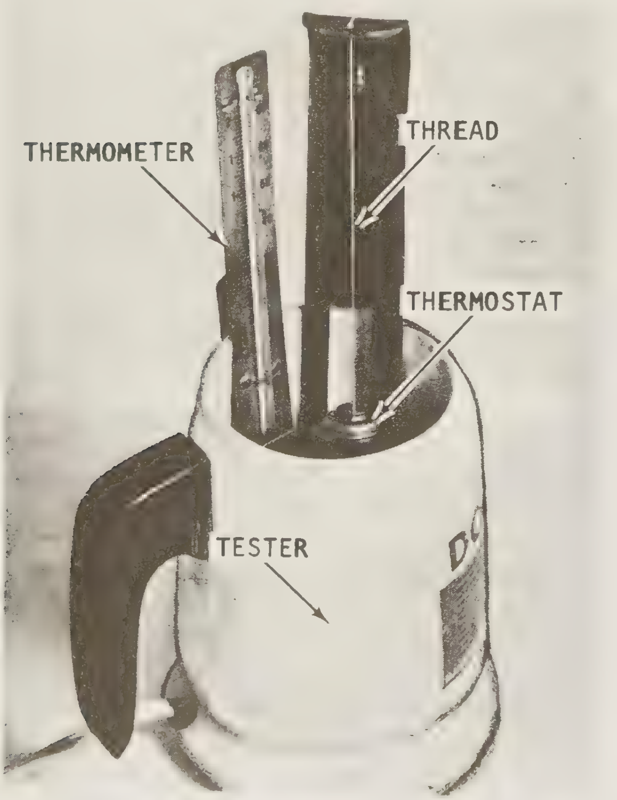
THERMOSTAT SERVICE

Inspect the thermostat cover and the thermostat opening in the cylinder head cover for cracks and corrosion damage. Such damage could cause leakage. Remove and **DISCARD** the old thermostat gasket. Wash the thermostat with clean water.

Obtain a thermostat tester or similar device, as shown in the accompanying illustration. Test the thermostat as follows:

a- Open the thermostat valve. Insert a length of thread between the valve and the thermostat body. Allow the valve to close against the thread.

b- Suspend the thermostat by the thread inside the tester. Do not allow the thermostat to touch the bottom or sides of the tester.



Thermostat suspended with a thermometer in a container, ready for testing, as described in the text.

c- Suspend a thermometer inside the tester, with the bottom of the thermometer even with the bottom of the thermostat. Do not allow the thermometer to touch the bottom or sides of the tester.

d- Fill the tester with water to cover the thermostat. Plug the tester into an electrical outlet.

e- Observe the temperature at which the thermostat begins to open. As soon as the thermostat starts to open, it will drop off the thread. Thermostat must begin to open at 140° to 145°F.

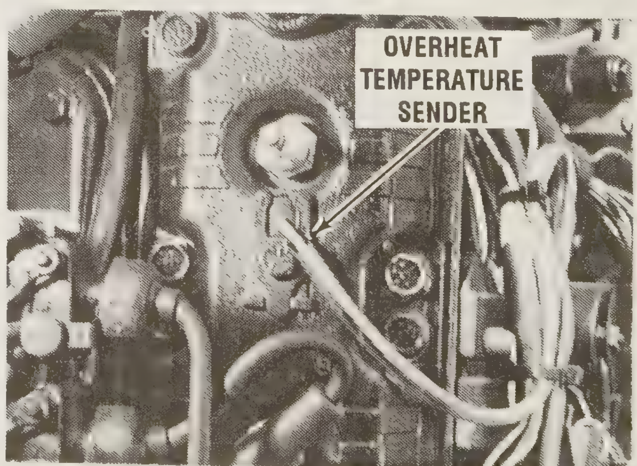
f- Continue to heat the water until the thermostat is completely open. Unplug the tester.

g- Allow the water in the tester to cool before testing the next thermostat.

Replace the thermostat, if it fails to open at the specified temperature, or if it does not fully open.

Two different temperature senders may be installed on the V6 powerheads covered in this manual. The sender is actually an electrical switch designed to close at a preset temperature and allow current to flow. One unit is a 190°F, the other, a 240°F sender. The location of the temperature sender on the powerhead determines the heat range of the sender. A sender installed directly below the spark plug opening is rated at 240°F and will activate the overheating alarm at 248°F. The 190°F sender is installed on the outer side of a cylinder head and will activate the overheating alarm at 198°F.

Because of their heat range, the sender cannot be tested in the same manner as a



Location of the powerhead overheat temperature sender just below the No. 1 spark plug -- starboard head. Another is installed below the No. 2 plug -- port head.

thermostat. Therefore, if the sender is suspected as being faulty, remove the unit and replace it with a new one.

REED BLOCK SERVICE

DO NOT remove the reeds, unless they are to be replaced. **ALWAYS** replace reeds in sets. **NEVER** turn used reed over to be used a second time.

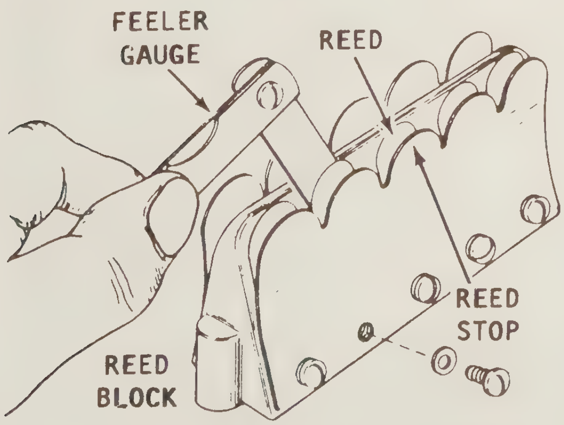
Clean the gasket surfaces of the reed blocks and the reed block housing. Inspect the surfaces for any signs of damage, deep grooves, cracks or distortion that might cause leakage. Check the face of each reed block to be sure a reed has not made an indentation. Check for chipped or broken reeds. Replace any damaged parts.

Assembling

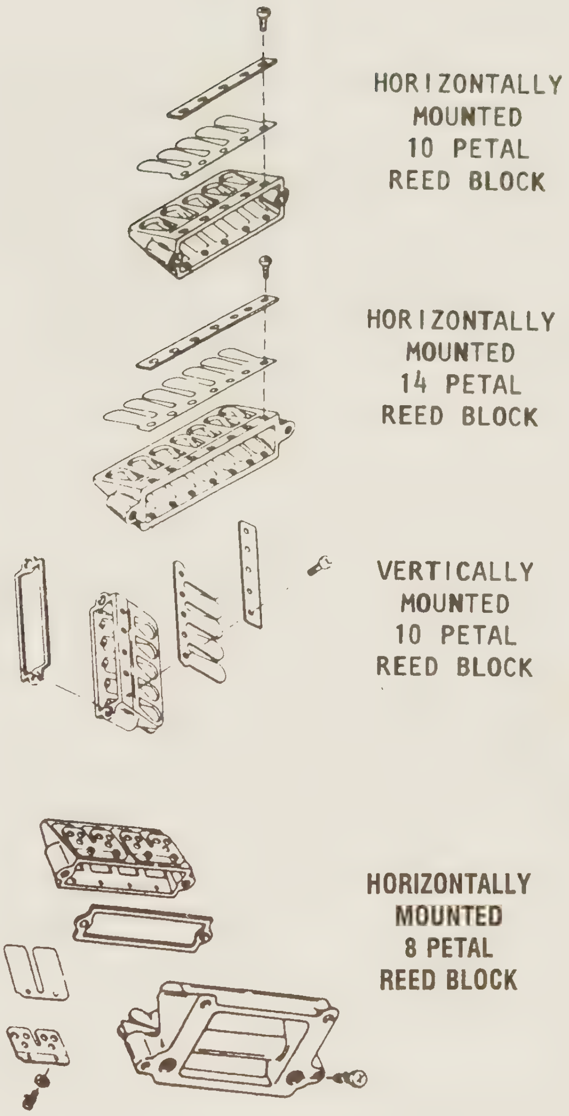
Place the reeds and the reed stops in position on the reed blocks. Secure the reeds and stops in place with the screws and lockwashers. Tighten the screws to the torque value given in the Specifications in the Appendix. Check to be sure the reeds are preloaded. They should not adhere to the reed block and still there should not be more than 0.020" (.51mm) clearance between the reed and the reed block surface.

Check each reed stop to be sure they are not bent sideways. Refer to the reed stop opening chart in the Appendix for the correct dimension for the powerhead being serviced.

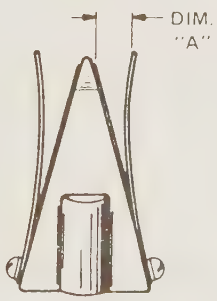
Place the reed block gaskets, and then the reed blocks into position in the reed block housing.



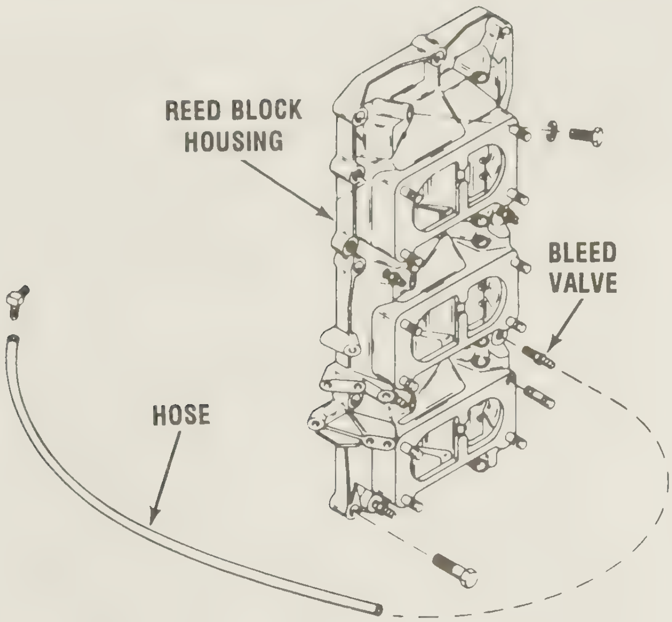
Measuring the reed opening with a feeler gauge, as described in the text.



Four different reed designs are used on the powerheads covered in this manual.



The dimension shown indicates the reed stop opening. These dimensions are listed in a table in the Appendix.



Inspect the passageways in the reed block to verify they are clear and unobstructed.

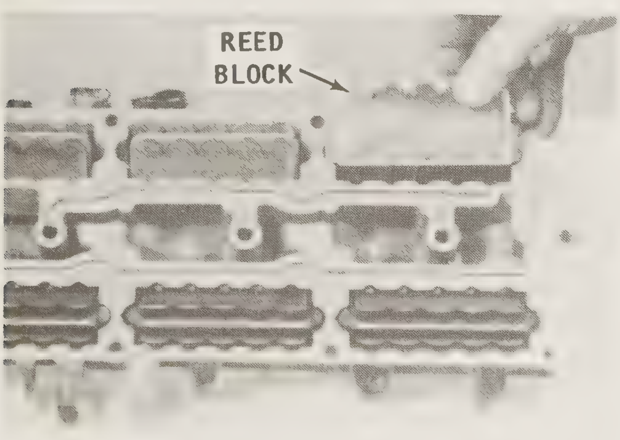
CRITICAL WORDS

When one "teardrop" reed and one "straight cut" reed are used, the reed block **MUST BE** installed in the reed block housing with the "teardrop" reed toward the center (inside) of the reed block housing.

Check the reed location over the reed block openings to be sure the reed is centered.

REED BLOCK HOUSING

Check all rubber bleed hoses for cuts, cracks, and deterioration. If any hose shows signs of wear or damage, then the hose **MUST** be replaced. Check to be sure the bleed system check valves are threaded tightly into the reed housing.



Vertical reed mounted powerhead.

Verify operation of the bleed system check valve by attempting to blow air through each check valve, in both directions . If air passes through the check valve in only one direction, the valve is operating properly. If air passes through the valve in **BOTH** directions, the valve is defective and **MUST** be replaced.

Visually check all the passages in the reed block housing for obstruction.

CRANKSHAFT SERVICE

Inspect the splines for signs of abnormal wear. Check the crankshaft for straightness. Inspect the crankshaft oil seal surfaces to be sure they are not grooved, pitted or scratched. Replace the crankshaft if it is severely damaged or worn. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear or overheating. Clean the crankshaft surfaces with 320 grit carborundum cloth. **NEVER** spin-dry a crankshaft ball bearing with compressed air.

Clean the crankshaft and crankshaft ball bearing with solvent. Dry the parts, but not the ball bearing with compressed air. Check the crankshaft surfaces a second time. Replace the crankshaft if the surfaces cannot be cleaned properly for satisfactory service. If the crankshaft is to be installed for service, lubricate the surfaces with light oil. **DO NOT** lubricate the crankshaft ball bearing at this time.

Cleaning the crankshaft with crocus cloth.

CRANKSHAFT AND END CAP BEARINGS

After the crankshaft has been cleaned, grasp the outer race of the crankshaft ball bearing installed on the lower end of the crankshaft, and attempt to work the race back-and-forth. There should not be excessive play. A very slight amount of side play is acceptable because there is only about 0.001" (0.025mm) clearance in the bearing.

Lubricate the ball bearing with light oil. Check the action of the bearing by rotating the outer bearing race. The bearing should have a smooth action and no rust stains. If the ball bearing sounds or feels rough or catches, the bearing should be removed and discarded.

Clean the crankshaft center main roller bearings with solvent and then dry them thoroughly, **BUT NOT** with compressed air. Lubricate the bearings with light weight oil. **NEVER** intermix halves of upper and lower crankshaft center main roller bearings. The bearings **MUST** be replaced only in pairs.

Inspect the center main roller bearings. Replace the bearings in pairs if they are rusted, fractured, worn, galled or badly discolored.

Clean the crankshaft roller bearings installed in the upper end cap with solvent, and then dry them **BUT NOT** with compressed air. Lubricate the bearings with light weight oil.

Inspect the upper end cap roller bearing to be sure it is not rusted, fractured, worn, galled, or badly discolored. If the bearing is damaged, it should be removed and discarded.

CONNECTING ROD SERVICE

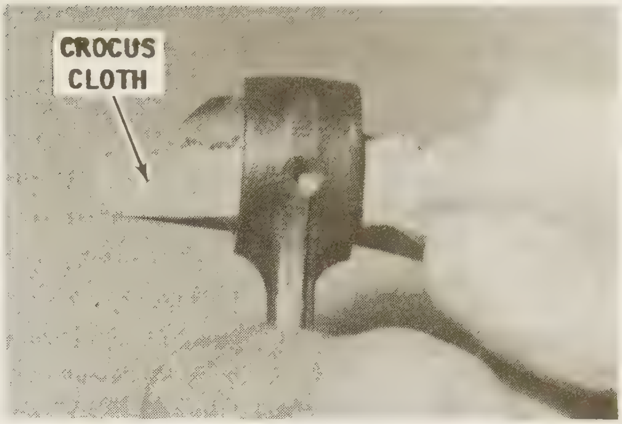
Clean the connecting rods with solvent and dry them with compressed air. Working with one rod at a time, remove the rod cap from the connecting rod. Lay the connecting rod horizontally on a surface plate and check the alignment. The rod is bent and unfit for further service, if:

a- Light can be seen under any portion of the machined surfaces.

b- The rod has a slight wobble on the plate.

c- A 0.002" (.051mm) feeler gauge can be inserted between the connecting rod machined surface and the surface plate.

Stand the connecting rod upright on the surface plate with the machined surface of the crankpin journal facing down. Check for the same defects as described in **a thru c.** Repeat the same inspection on all the remaining connecting rods. If a connecting rod is found to be defective, the rod **MUST** be replaced.



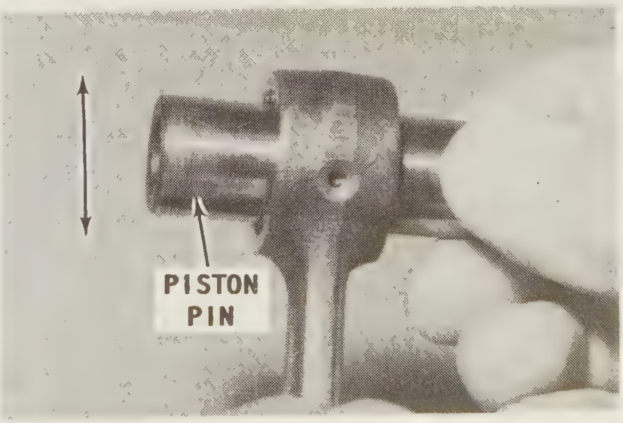
Cleaning the piston end of a connecting rod with crocus cloth.

Inspect the connecting rod bearings for rust or signs of bearing failure. **NEVER** intermix new and used bearings. If even one bearing in a set needs to be replaced, all bearings at that location **MUST** be replaced.

Inspect the bearing surface of the rod and the rod cap for rust and pitting.

Inspect the bearing surface of the rod and the rod cap for water marks. Water marks are caused by the bearing surface being subjected to water contamination, which causes "etching". The etching resembles the size of the bearing as shown in the accompanying illustration.

Inspect the bearing surface of the rod and rod cap for signs of spalling. Spalling is the loss of bearing surface, and resembles flaking or chipping. The spalling condition will be most evident on the thrust portion of the connecting rod in line with the I-beam.



Checking the piston end of a connecting rod for vertical free "play" using a piston pin.

Bearing surface damage is usually caused by improper lubrication.

Check the bearing surface of the rod and rod cap for signs of chatter marks. This condition is identified by a rough bearing surface resembling a tiny washboard. The condition is caused by a combination of low-speed low load operation in cold water, and is aggravated by inadequate lubrication and improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second, until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. In some instances, the connecting rod crankpin bore becomes highly polished.

While the engine is running, a "whirr" and/or "chirp" sound may be heard when the engine is accelerated rapidly from idle speed to about 1500 rpm, then quickly returned to idle. If chatter marks are discovered, the crankshaft and the connecting rods should be replaced.

Inspect the bearing surface of the rod and rod cap for signs of uneven wear and possible overheating. Uneven wear is usually caused by a bent connecting rod or by improper shimming of the crankshaft end play, failure to maintain the same amount of shim material under each end cap. This improper shimming causes the crankshaft journal not to be centered over the cylinder bore. Overheating is identified as a bluish bearing surface color and is caused by inadequate lubrication or operating the engine at excessively high rpm.

Service the connecting rod bearing surfaces according to the following procedures and precautions.

a- Align the etched marks on the connecting rod with the etched marks on the connecting rod cap.

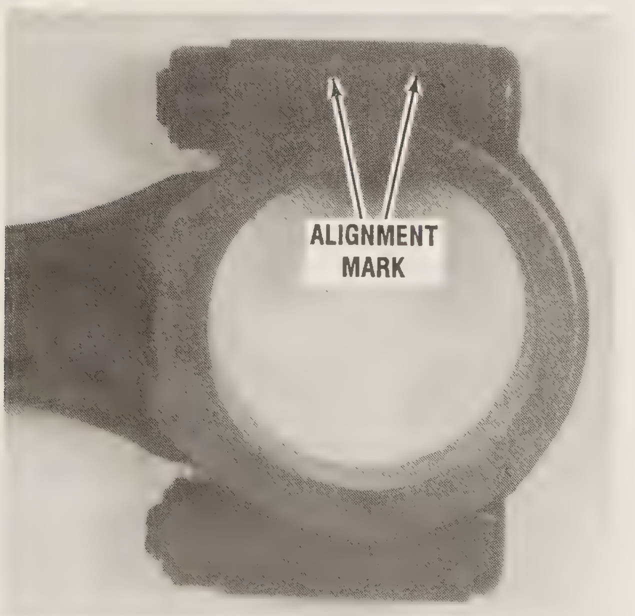
b- Tighten the connecting rod cap attaching bolts securely.

c- Two types of bearings are used on the crankpin end of the rod. One is a noncaged type with individual needles. The other is a caged type with separate rollers. Clean the caged type with 320 grit carborundum cloth.

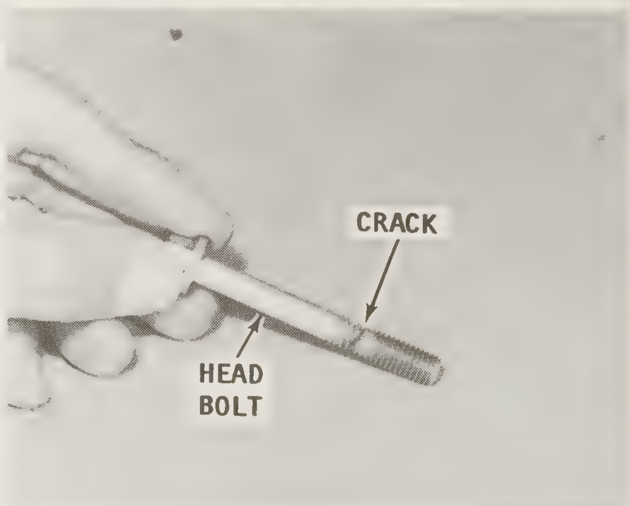
d- Use **ONLY** crocus cloth to clean the bearing surface at the crankshaft end of the connecting rod. **NEVER** use any other type of abrasive material.

e- Insert the cloth in a slotted 3/8" (9.5mm) diameter shaft. Chuck the shaft in a drill press and operate the press at high speed and at the same time, keep the connecting rod at a 90° angle to the slotted shaft.

f- Clean the connecting rod **ONLY** enough to remove marks. **DO NOT** continue, once the marks have disappeared.



Alignment marks embossed on the rod and rod cap. The marks on this set are aligned.



A "lucky break". This head bolt was tightened beyond the recommended torque value. The bolt cracked, but fortunately not all the way through. If the bolt had broken completely, leaving part in the block, the hole would require drilling and tapping oversize for a larger size bolt.

The pitted damage to this piston crown was probably caused by a broken piston ring working its way into the combustion chamber. The little "hills" then became "hot" spots on the crown, contributing to "dieseling" after the powerhead was shut down.

g- Clean the piston pin end of the connecting rod using the method described in Step "e", above, using 320 grit carborundum cloth.

h- Thoroughly wash the connecting rods to remove abrasive grit. After washing, check the bearing surfaces a second time.

i- If the connecting rod cannot be cleaned properly, it should be replaced.

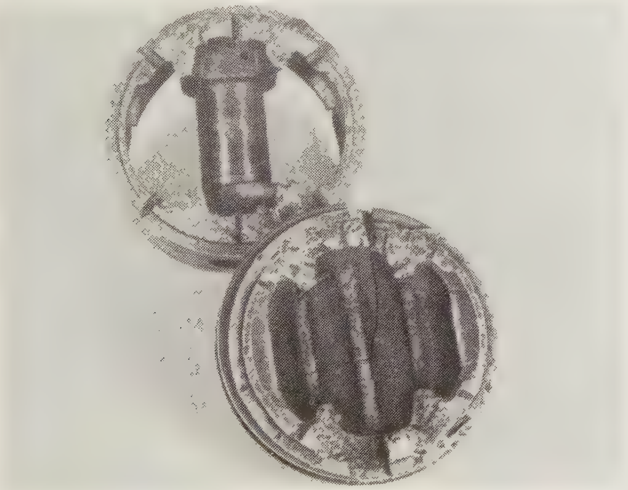
j- Lubricate the bearing surfaces of the connecting rods with light weight oil to prevent corrosion.

PISTON SERVICE

CRITICAL WORDS

If the powerhead was submerged while it was running, the piston pin and/or the connecting rod may be bent. If the piston pin is bent, the piston **MUST** be replaced. Piston pins are **NOT** sold separately, because of a matched fit with the pistons. If the piston pin is bent, the connecting rod **MUST** be checked for straightness as described in earlier paragraphs of this section.

Inspect each piston for evidence of scoring, cracks, metal damage, cracked or worn piston pin and piston pin boss. Be especially critical during inspection if the powerhead was submerged. If a piston pin is bent, the pin and piston **MUST** be replaced as a matched set, because the pin will damage the boss when it is removed. Clean carbon deposits from the top of the pistons using a soft wire brush, carbon removal solution or by sand blasting. If a wire brush is used, **TAKE CARE** not to burr or round machined edges. Clean the piston skirt with crocus cloth.



It is believed, this crown seized with the cylinder wall when the unit was operated at high rpm and the timing was not adjusted properly. At the same instant, the rod pulled the lower part of the piston downward severing it from the crown.

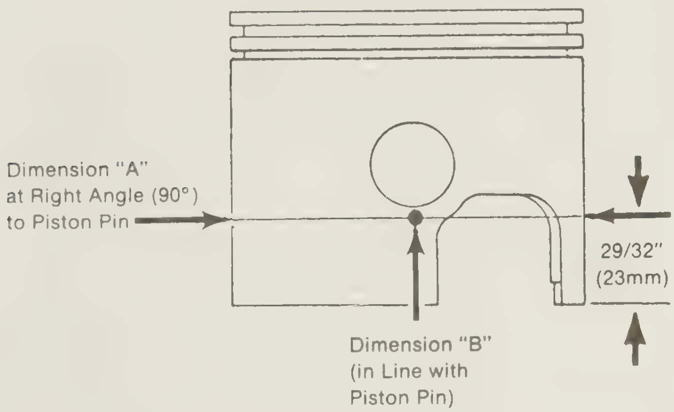
PISTON ROUNDNESS

After the pistons have been cleaned, check each piston for size and roundness using a micrometer and one of the following illustrations -- on the next page -- for the size powerhead being serviced. Measure up from the bottom of the piston skirt the dimension given in the illustration. Next, measure the width of the piston skirt for dimension "A" at the points indicated. Now, move the micrometer 90° (directly under the piston pin boss) and measure the width of the piston skirt for dimension "B". The maximum allowable difference between dimension "A" and "B" is listed in the chart for each size powerhead. If the measurements exceed the allowable limit, the piston **MUST** be replaced.

Example of using a micrometer to measure piston skirt diameter, as described in the text. Illustrations showing exactly where and how these dimensions are to be taken and the dimension limits are given on the next page. The horsepower and cubic inch displacement are listed.

MODELS 135,150 - 122 CU. IN.	
PISTON	DIMENSION
Standard	3.115 in. +/- .002 in.
.015 in. Oversize	3.130 in. +/- .002 in.
.030 in. Oversize	3.145 in. +/- .002 in.

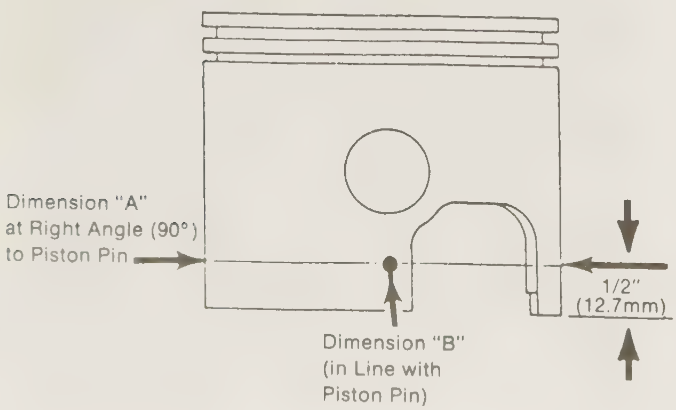
Measure dimension "A" and "B" at location shown. Dimension "B" should be within .008 in. of dimension "A".



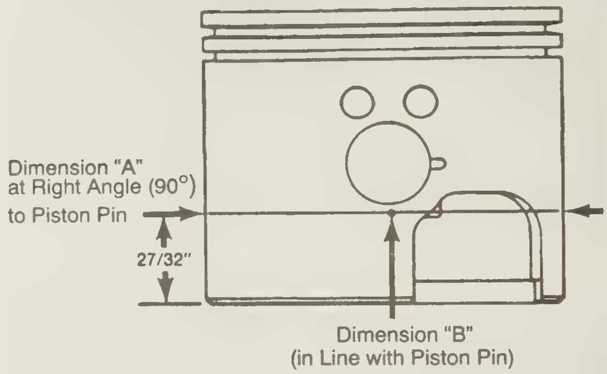
MODELS 150 XR4, MAGNUM II, 175, 175 XRi - 142 CU. IN.	
PISTON	DIMENSION
Standard	3.372 in. +/- .002 in.
.015 in. Oversize	N/A
.030 in. Oversize	N/A

MODELS 150 XR6, MAGNUM III, 175, 200 - 153 CU. IN.	
PISTON	DIMENSION
Standard	3.494 in. +/- .001 in.
.015 in. Oversize	3.509 in. +/- .001 in.
.030 in. Oversize	N/A

Measure dimension "A" and "B" at location shown. Dimension "B" should be within .008 in. of dimension "A".

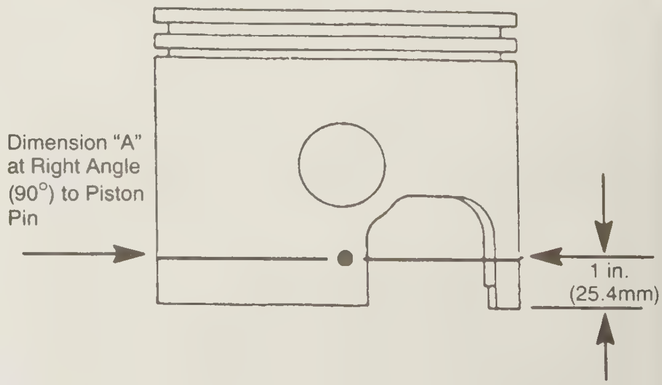


MODEL 225 - 185 CU. IN.	
PISTON	DIMENSION
Standard	3.6210 in. +/- .0005 in.
.015 in. Oversize	N/A
.030 in. Oversize	N/A



MODEL 275 - 207 CU. IN.	
PISTON	DIMENSION
Standard	3.732 in. +/- .001in.
.015 in. Oversize	N/A
.030 in. Oversize	N/A

Measure dimension "A" and "B" at location shown. Dimension "B" should be within .003 in. of dimension "A".



Piston Ring Identification

Pistons used with the powerheads covered in this manual may contain any one of three combinations of piston ring sets.

On some models the pistons contain one keystone, (tapered) ring on top and a rectangular ring on the bottom. On other models, the piston will use two keystone, (tapered) rings. The third combination is the use of two half keystone tapered rings.

Therefore, it will be necessary to measure the ring thickness in order to identify each ring, as shown in the accompanying illustrations. This information must be kept in mind when using a broken ring to clean the piston ring grooves.

Measure and identify the type of rings used on the pistons being serviced.

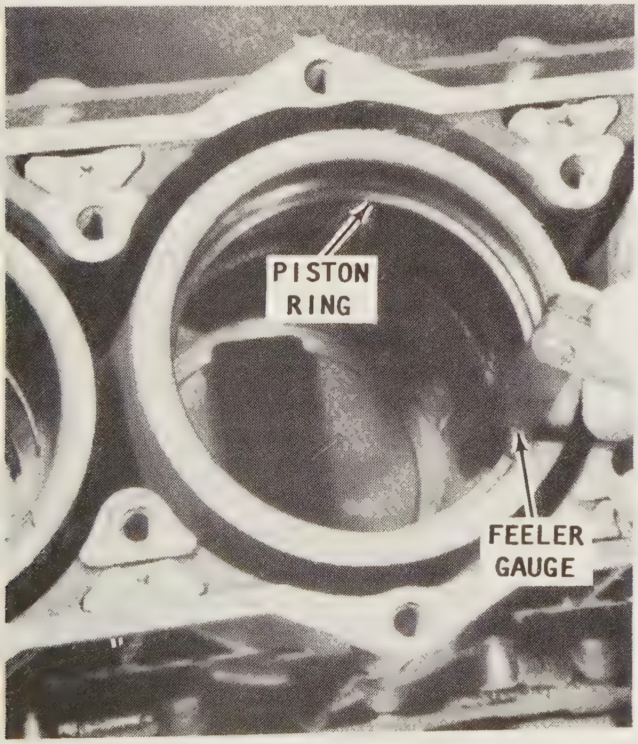
Inspect the piston ring locating pins to be sure they are tight. There is one locating pin in each ring groove. If the locating pin/s are loose, the piston must be replaced.

Ring End Gap Clearance

Check each ring to be sure the end gap is not excessive. The end gap may be checked by placing the ring into the cylinder bore. Next, turn a piston upside down and insert the piston into the bore up against the ring. Now, push the piston ring down approximately 1/2" into the cylinder with the piston. This procedure will position the ring squarely in the cylinder for an accurate measurement. Withdraw the piston and measure the ring end gap with a feeler gauge. The allowable end gap measurements are listed in the next column by powerhead cubic inch displacement -- with horsepower rating in parentheses.

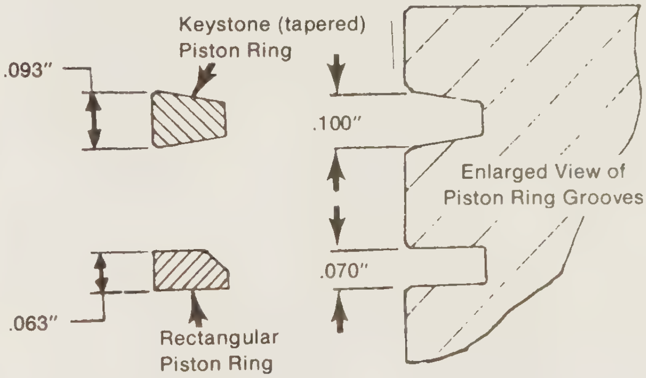
Repeat this procedure for all piston rings. Insert each ring into the proper cylinder using the numbered piston the ring will be installed onto.

If the end gap is less than the specified amount, filing the end of the ring is acceptable, provided all rough edges are removed after filing. If the gap is larger than the specified amount, obtain another new set of rings and re-check the end gap using the new rings. If the end gap is still too large, the block is worn excessively and **MUST** be bored to the next oversize or replaced.

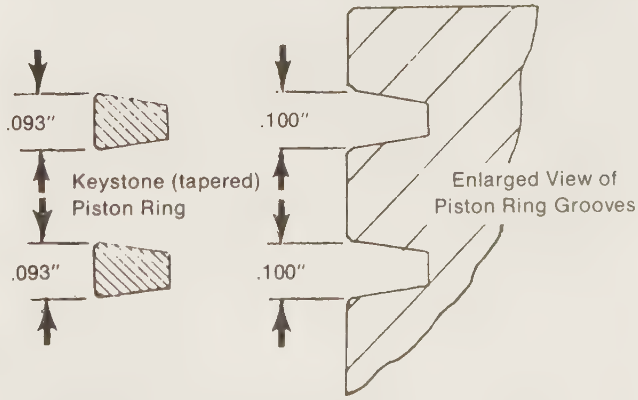


Example of using a feeler gauge to accurately measure ring end gap. The ring must be "square" in the cylinder.

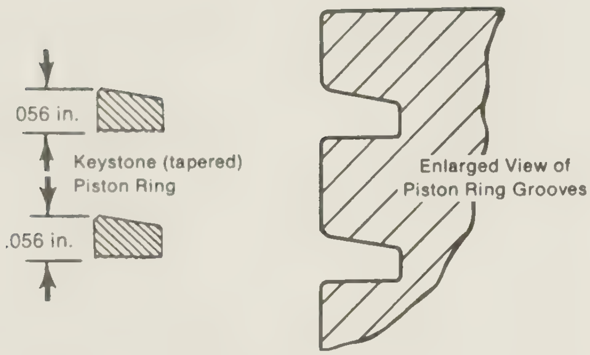
Powerhead Cubic Inch (Model hp)	Ring End Gap
122 (135/150hp)	0.018" - 0.025" (0.45mm - 0.64mm)
142 (175hp)	0.018" - 0.025" (0.45mm - 0.64mm)
153 (200hp)	0.018" - 0.025" (0.45mm - 0.64mm)
185 (225hp)	0.010" - 0.018" (0.25mm - 0.45mm)
207 (275hp)	0.012" - 0.024" (0.30mm - 0.61mm)



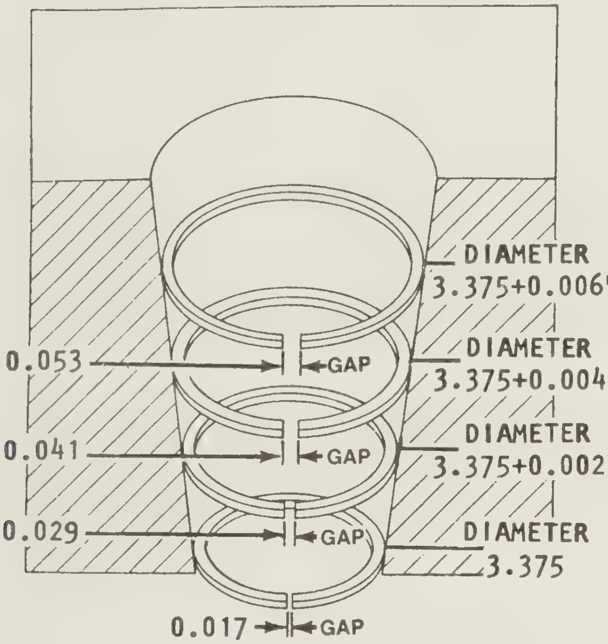
Piston using a keystone (tapered), ring in the top groove and a rectangular ring in the bottom groove.



Piston using a keystone (tapered), ring in both the top and bottom groove.



Piston using a half keystone (tapered), ring in both the top and bottom grooves.



The cylinder taper drastically affects ring end gap, as shown in this cross section line drawing.

CYLINDER BLOCK SERVICE

FIRST, THESE WORDS

The crankcase cover and the cylinder block are a matched, line bored assembly. Therefore, the cover and the block should **ALWAYS** be kept together and **NEVER** mismatched with a part from another set. If the crankcase cover or cylinder block is to be submerged in a very strong cleaning solution, the crankcase cover/cylinder block bleed system **MUST** be removed to prevent damage to the hoses and check valves.

Clean the cylinder block and crankcase cover. Pay particular attention to remove all sealant and old gasket material from matching surfaces. Remove all carbon deposits from the exhaust ports.

Inspect the gasket surfaces for nicks, deep grooves, cracks or any distortion which might cause a compression leak.

Inspect the gasket surfaces for nicks, deep grooves, cracks or any distortion which might cause a compression leak.

Check all water and oil passages in the cylinder block and crankcase cover to be sure they are not obstructed. Check to sure the plugs are in place and tight.

Cylinder Bore Cleaning and Inspecting

CRITICAL WORDS

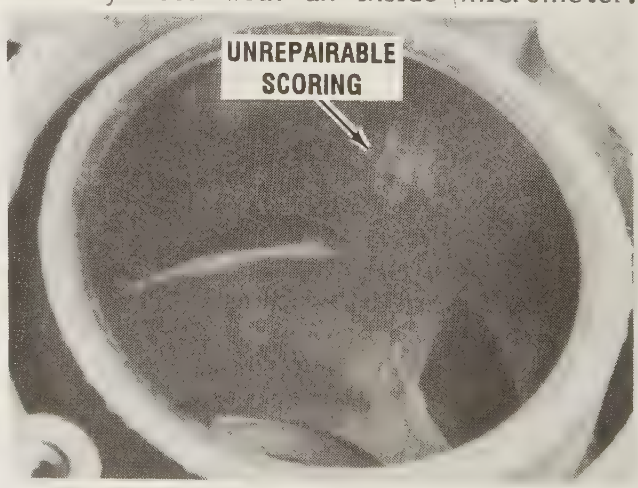
The cylinder bores of the 1990 Model 175, 200, 200XRI, and all model 225 and 275hp have chrome finished cylinder bores. Therefore, the inspection and cleaning procedures for these models are different from all other models which have cast iron sleeves. Note and **FOLLOW** these differences closely.

Hardened Steel Cylinder Bores

Inspect the cylinder bores for scoring. Scoring is considered the transfer of aluminum from the piston to the cylinder wall. A scored cylinder wall can usually be returned to satisfactory service by cleaning and honing as outlined later in this section.

NEVER use the hone more than absolutely necessary to deglaze the cylinder wall during the honing process, because the hone can remove cylinder wall material rapidly. Remove the hone frequently and check the condition of the wall.

Measure the cylinder bore diameter of each cylinder with an inside micrometer.



The wall of this cylinder was damaged beyond repair when a piston ring broke and worked its way into the combustion chamber.

Check for tapered, out of round, and oversize bore condition. Refer to the Specifications in the Appendix.

If a cylinder bore is tapered, out of round or worn more than 0.006" (.15mm) from standard Cylinder Block Finish Hone diameter, it will be necessary to rebore that particular cylinder to 0.015" (.38mm) or 0.030" (.76mm) oversize and install an oversize piston and ring assembly.

GOOD WORDS

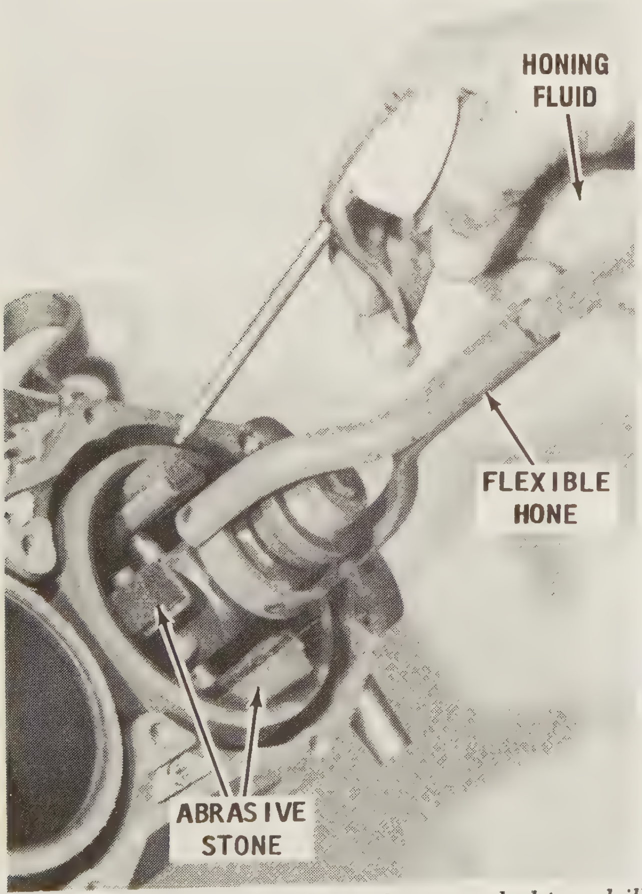
Oversize piston weight is approximately the same as a standard size piston. Therefore, it is **NOT** necessary to rebore all cylinders in a block just because one cylinder requires reboring. The APBA (American Power Boat Association) accepts and permits the use of 0.015" (.38mm) oversize pistons.

HONING PROCEDURES

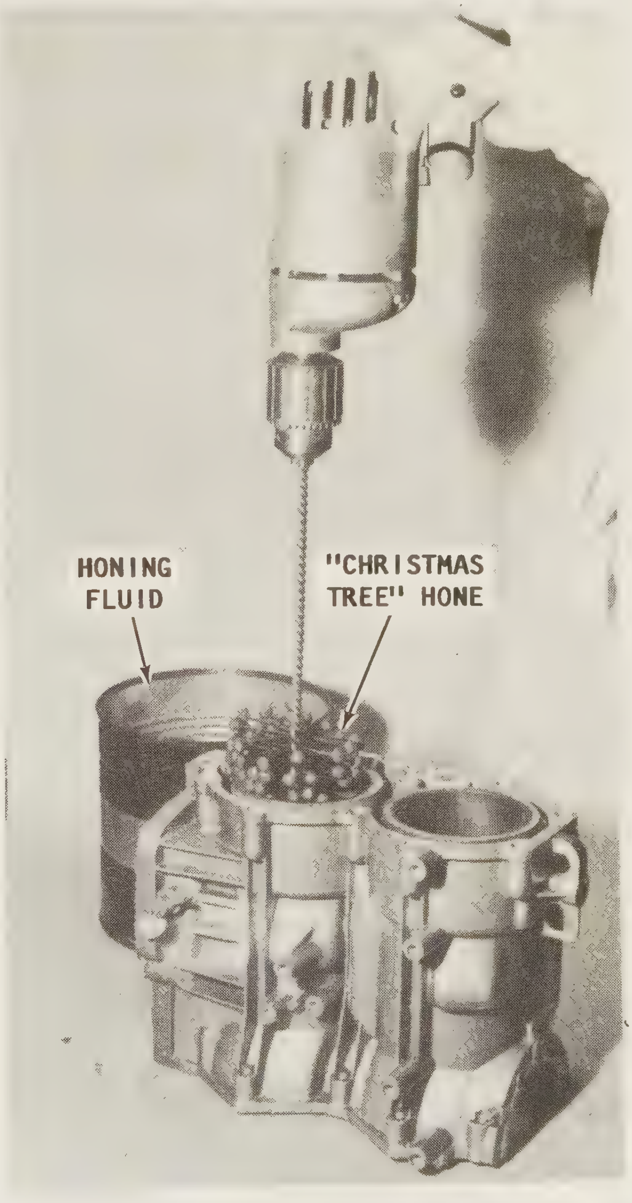
To ensure satisfactory engine performance and long life following the overhaul work, the honing work should be performed with patience, skill, and in the following sequence:

a- Follow the hone manufacturer's recommendations for use of the hone and for cleaning and lubricating during the honing operation.

b- Pump a continuous flow of honing oil into the work area. If pumping is not practical, use an oil can. Apply the oil generously and frequently on both the stones and work surface.



Example of using a flexible hone attached to a drill motor to hone a cylinder wall. This type hone is adjustable for various size cylinders.



Example of refinishing a cylinder wall using an electric drill and a "Christmas Tree" hone. ***ALWAYS*** *keep the tool moving in long even strokes the entire cylinder depth. The powerhead shown is a 2-cylinder, 4-stroke block, but the technique is the same for V6 powerheads covered in this manual.*

c- Begin the stroking at the smallest diameter. Maintain a firm stone pressure against the cylinder wall to assure fast stock removal and accurate results.

d- Expand the stones as necessary to compensate for stock removal and stone wear. The best crosshatch pattern is obtained using a stroke rate of 30 complete cycles per minute. Again, use the honing oil generously.

e- Hone the cylinder walls **ONLY** enough to deglaze the walls.

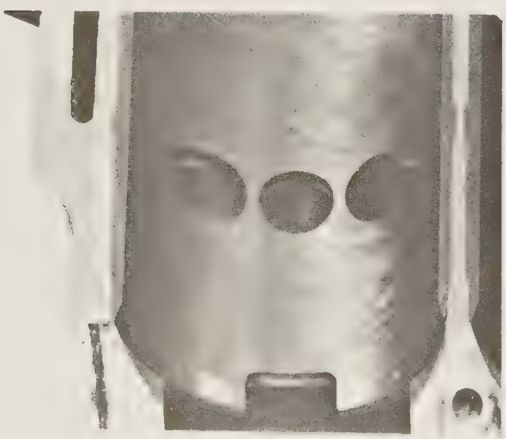
f- After the honing operation has been completed, clean the cylinder bores with hot water and detergent. Scrub the walls with a stiff bristle brush and rinse thoroughly with hot water. The cylinders **MUST** be thoroughly cleaned to prevent any abrasive material from remaining in the cylinder bore. Such material will cause rapid wear of new piston rings, the cylinder bore, and the bearings.

g- After cleaning, swab the bores several times with engine oil and a clean cloth, and then wipe them dry with a clean cloth. **NEVER** use kerosene or gasoline to clean the cylinders.

h- Clean the remainder of the cylinder block to remove any excess material spread during the honing operation.

SPECIAL WORDS

If overheating has occurred, check and resurface the spark plug area of the cylinder block, if necessary. This can be accomplished with 240 grit sandpaper. Use a circular motion to prevent leaving grooves from finger pressure through the sandpaper.



This sectioned cylinder shows an ideal crosshatch pattern on the cylinder wall. The pattern is necessary to seat the rings against the cylinder wall to provide an adequate seal for maximum compression.

Cast iron cylinder sleeves are an integral part of the die cast aluminum block and **CANNOT** be replaced. In other words, the cast iron cylinder cannot be re-sleeved.

CYLINDER BLOCK SERVICE

Inspect the cylinder block and cylinder bores for cracks or other damage. Remove carbon with a fine wire brush on a shaft attached to an electric drill or use a carbon remover solution.

STOP!

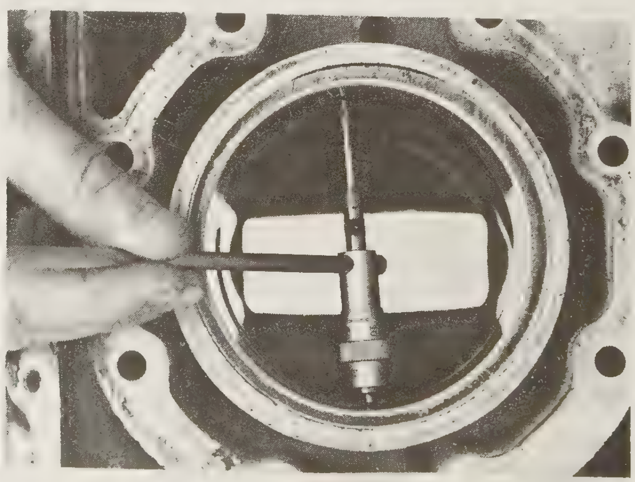
If the cylinder block is to be submerged in a carbon removal solution, the crankcase bleed system **MUST** be removed from the block to prevent damage to hoses and check valves.

Use an inside micrometer or telescopic gauge and micrometer to check the cylinder for wear. Check the bore for out of round and/ or oversize bore. If the bore is tapered, out of round or worn more than 0.006" (0.152mm), the cylinder/s should be bored to 0.015" (0.38mm), or 0.030 (0.76mm,) oversize. Boring the cylinder/s will require oversize pistons and rings be installed.

Chrome Plated Cylinder Bores

TAKE NOTE: The cylinder wall of a chrome plated cylinder bore **CANNOT** be rebored or efficiently honed. Honing of a chrome cylinder is not necessary or recommended by the manufacturer.

Inspect the chrome surfaced cylinder bores for signs of flaking, grooving, scoring or other damage. **DO NOT** mistake porosity for a damaged cylinder.



Measuring the cylinder bore with an inside micrometer.

If inspection reveals the chrome surface is flaking, or if a groove or any other mark penetrates the chrome surfacing to the aluminum portion of the cylinder block, the cylinder block and crankcase cover **MUST** be replaced.

To determine if a groove or any other mark in the cylinder wall has penetrated the chrome surface to the aluminum, apply a small amount of muratic acid or toilet bowl cleaner over the groove or mark. **DO NOT** allow the acid or cleaner to contact the aluminum portion of the block. If a groove or mark penetrates the chrome surfacing, the acid or cleaner will "fizzle" or "bubble", indicating aluminum is being dissolved.

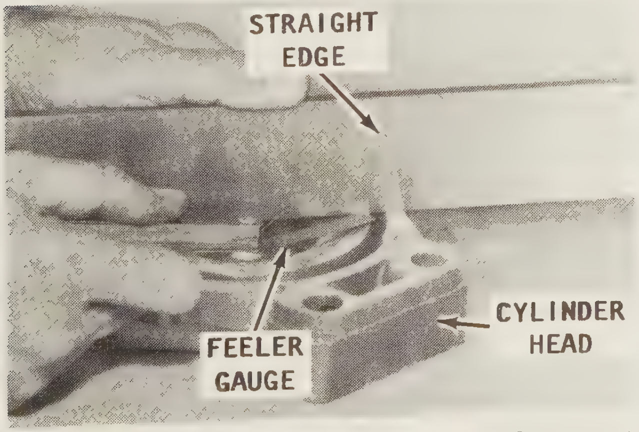
If a piston is scored and has transferred aluminum to the cylinder wall, the aluminum may be removed and the cylinder wall cleaned as follows:

a- Remove all loose aluminum deposits from the cylinder wall with a stiff bristle brush.

b- Apply a small amount of muratic acid, or toilet bowl cleaner, onto the aluminum deposits. **DO NOT** allow the acid or cleaner to contact the aluminum portion of the block. The acid or cleaner will begin to "fizzle" or "bubble" indicating the aluminum is being dissolved.

c- Leave the acid or cleaner on the aluminum deposit for a couple minutes, and then wash the cylinder thoroughly with hot water and detergent.

d- Repeat Steps **b** and **c** as many times as required to remove all aluminum deposits from the cylinder wall.



Example of using a straight edge and feeler gauge to check for cylinder head warpage, as described in the text. The head shown is from a small powerhead, but the technique is the same for the V6 powerheads covered in this manual. The mating surface of the cylinder block should also be checked in the same manner.

Use an inside micrometer and check each cylinder for an out of round condition. Take the measurement 1/4" from the top of the cylinder bore and at right angle (90°) to each other. An out of round condition of 0.006" or less is acceptable. If the out of round is more than 0.006", the cylinder block and crankcase cover **MUST** be replaced.

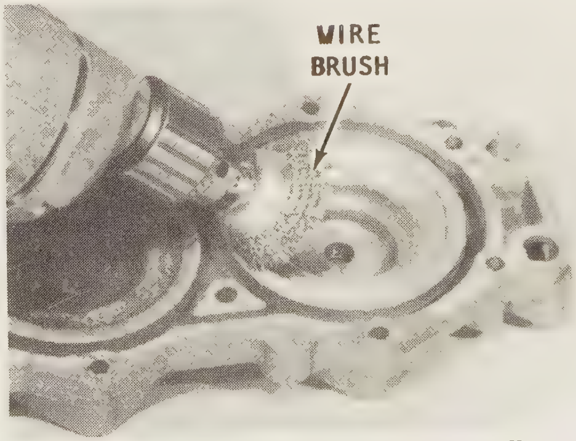
After all cleaning and inspecting procedures have been completed, coat the cylinder bores several times with light weight engine oil and a clean cloth.

CYLINDER HEAD AND EXHAUST COVER

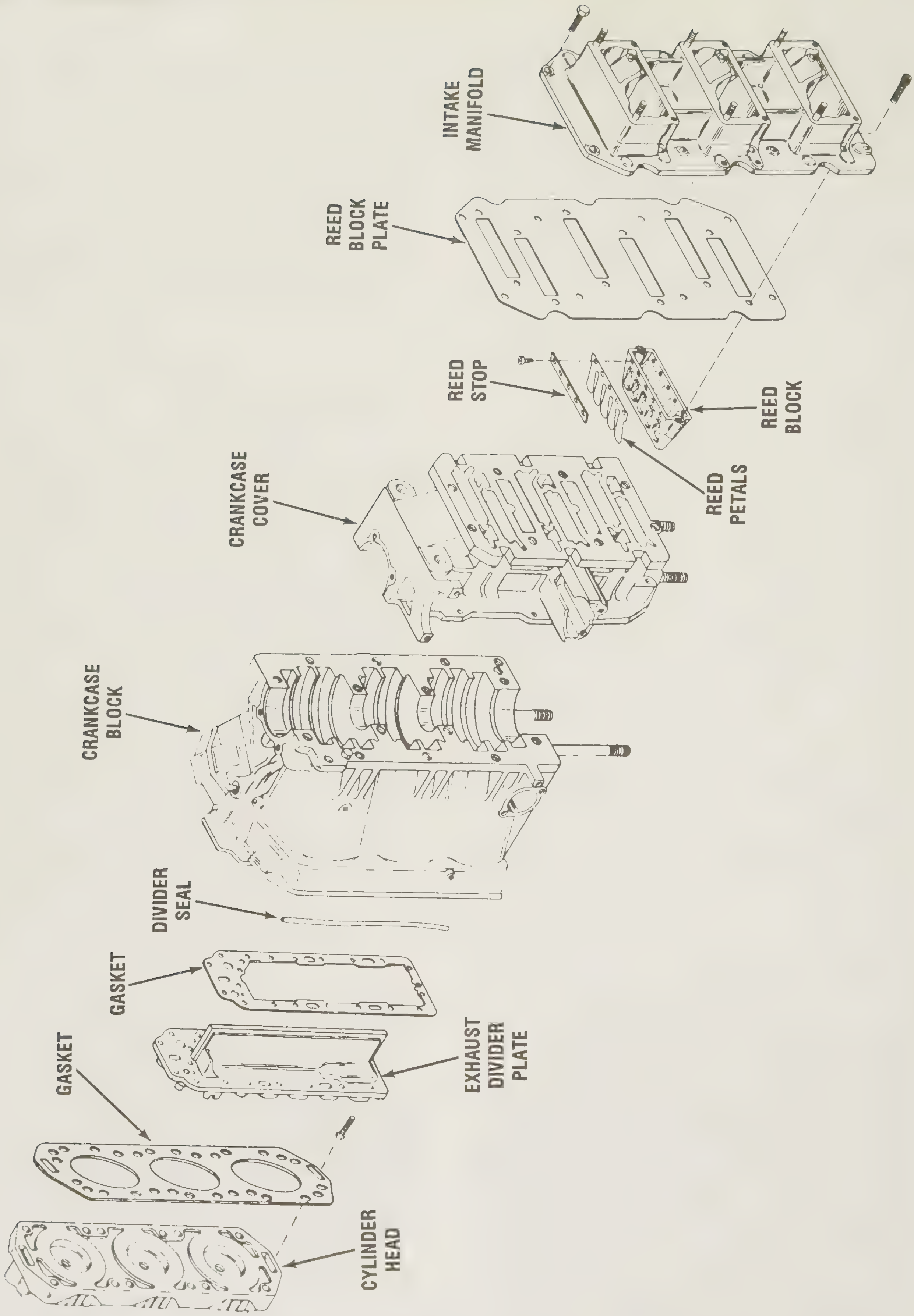
Clean the cylinder head gasket surfaces of all old gasket material with a wire brush. Remove all carbon deposits using a wire wheel or carbon removal solvent. Check the cylinder heads for deep grooves, cracks and damage from piston or foreign material striking the cylinder head.

Cylinder head warpage is checked by placing the cylinder head (face down), onto a surface plate. The cylinder head warpage should not exceed 0.004" (0.1mm) over the entire length of the head or a warpage of 0.004" (0.1mm), in any narrow portion of the head. If the cylinder head is found to be warped, it may be resurfaced and up to a maximum of .010" (.25mm), material is allowed to be removed from the surface of the cylinder head.

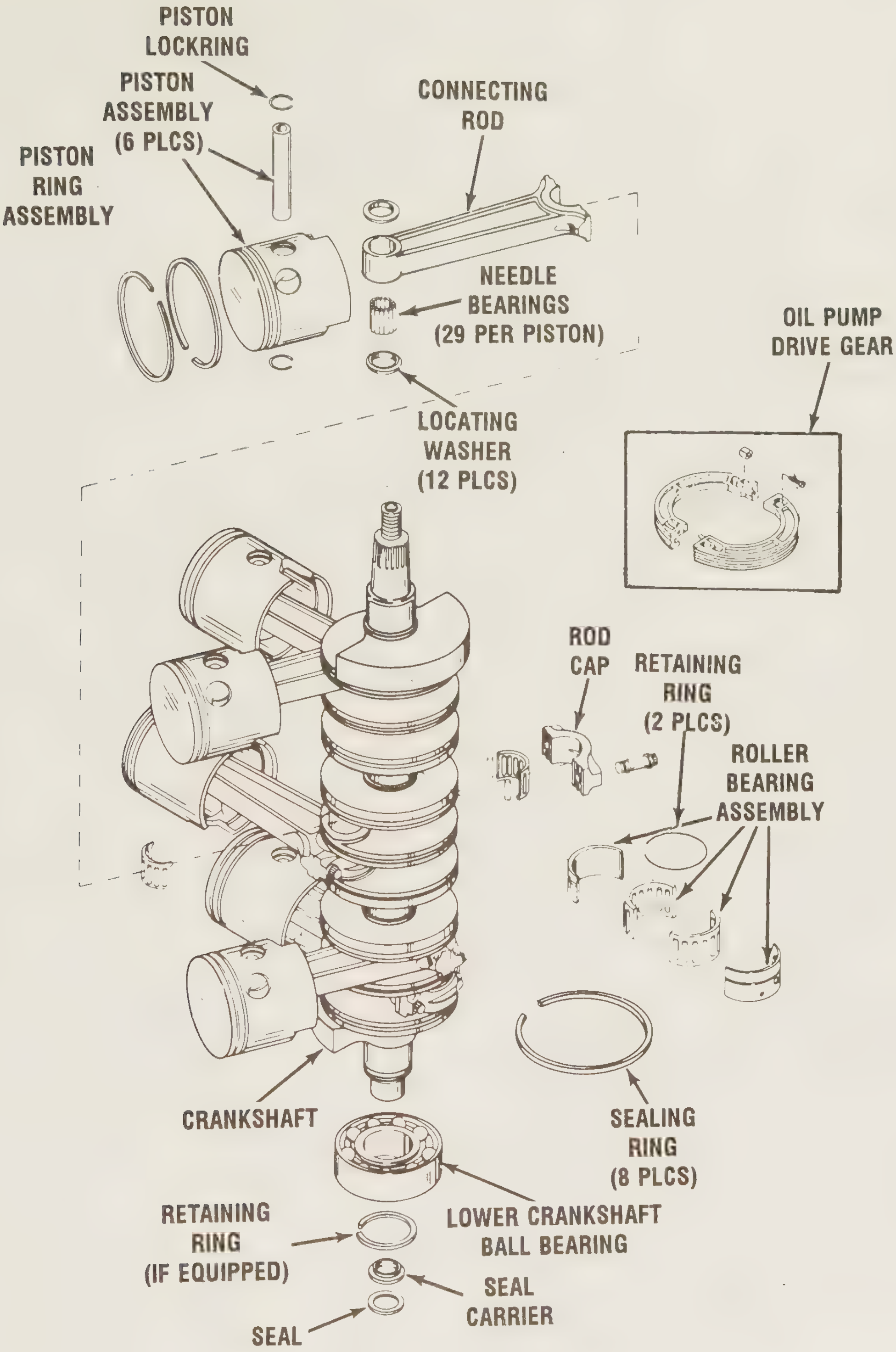
Clean all gasket surfaces on the exhaust divider plate and cover (if equipped). Check the cover and divider plate for deep grooves, cracks or distortion which could cause water leakage. Replace the cover and/or divider plate if defects are found.



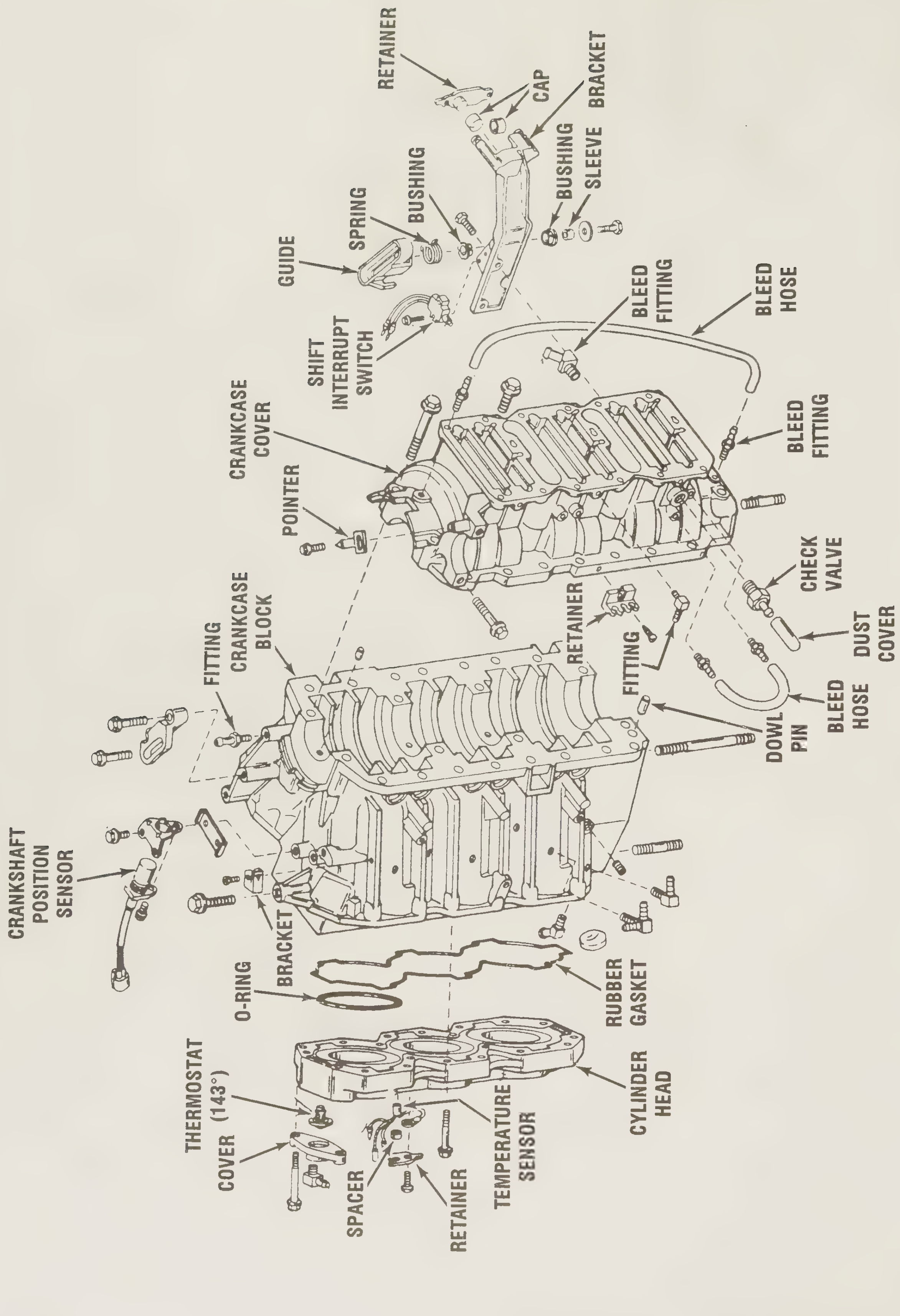
Example of using a wire brush and drill motor to clean carbon deposits from the combustion area of a cylinder head. The head shown is from a small 2-cylinder powerhead, but the procedure is the same for a V6.



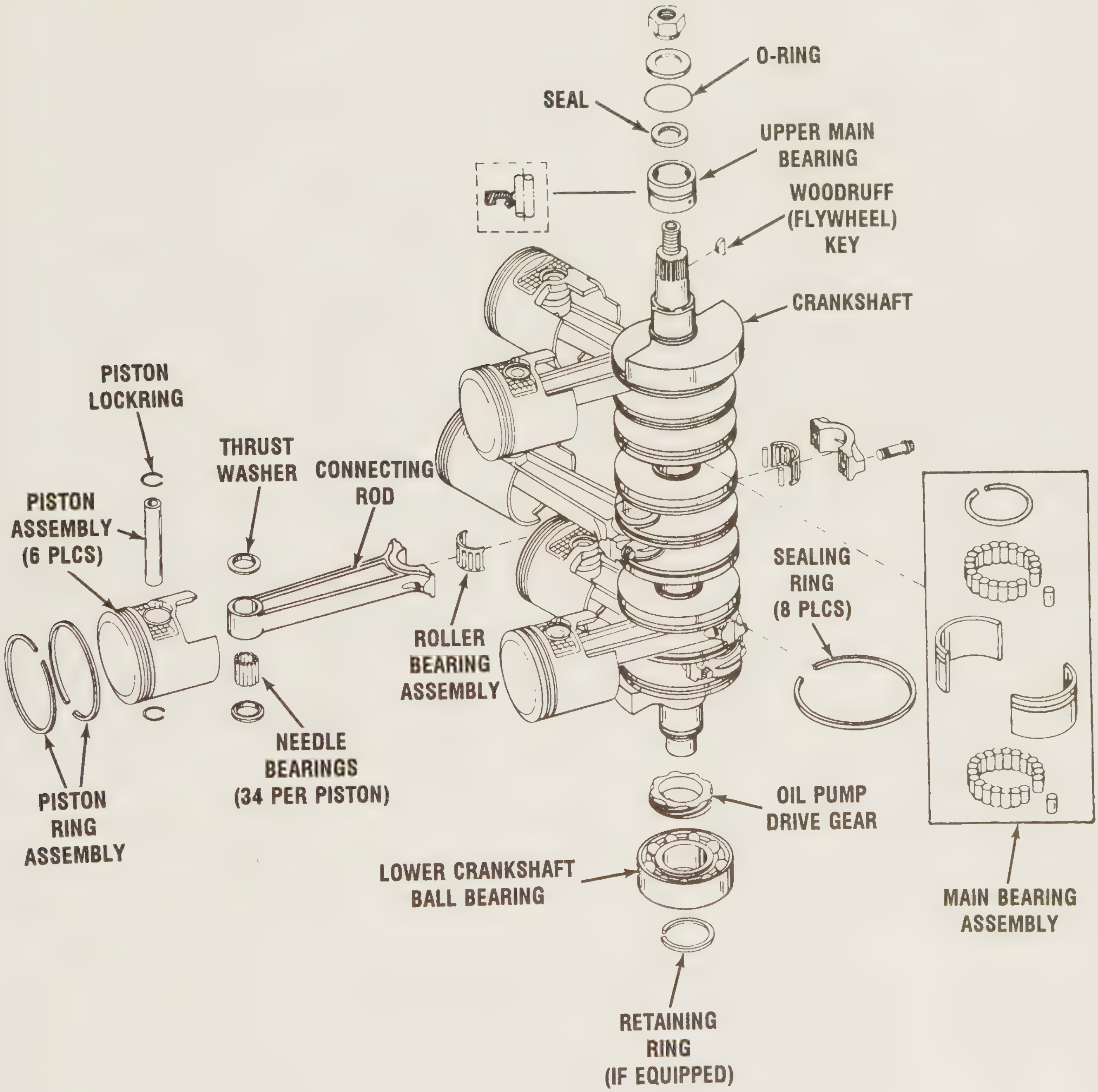
Exploded drawing of Model 135 thru 200hp powerhead block and associated parts. Major parts have been identified. The crankshaft is shown on the facing page.



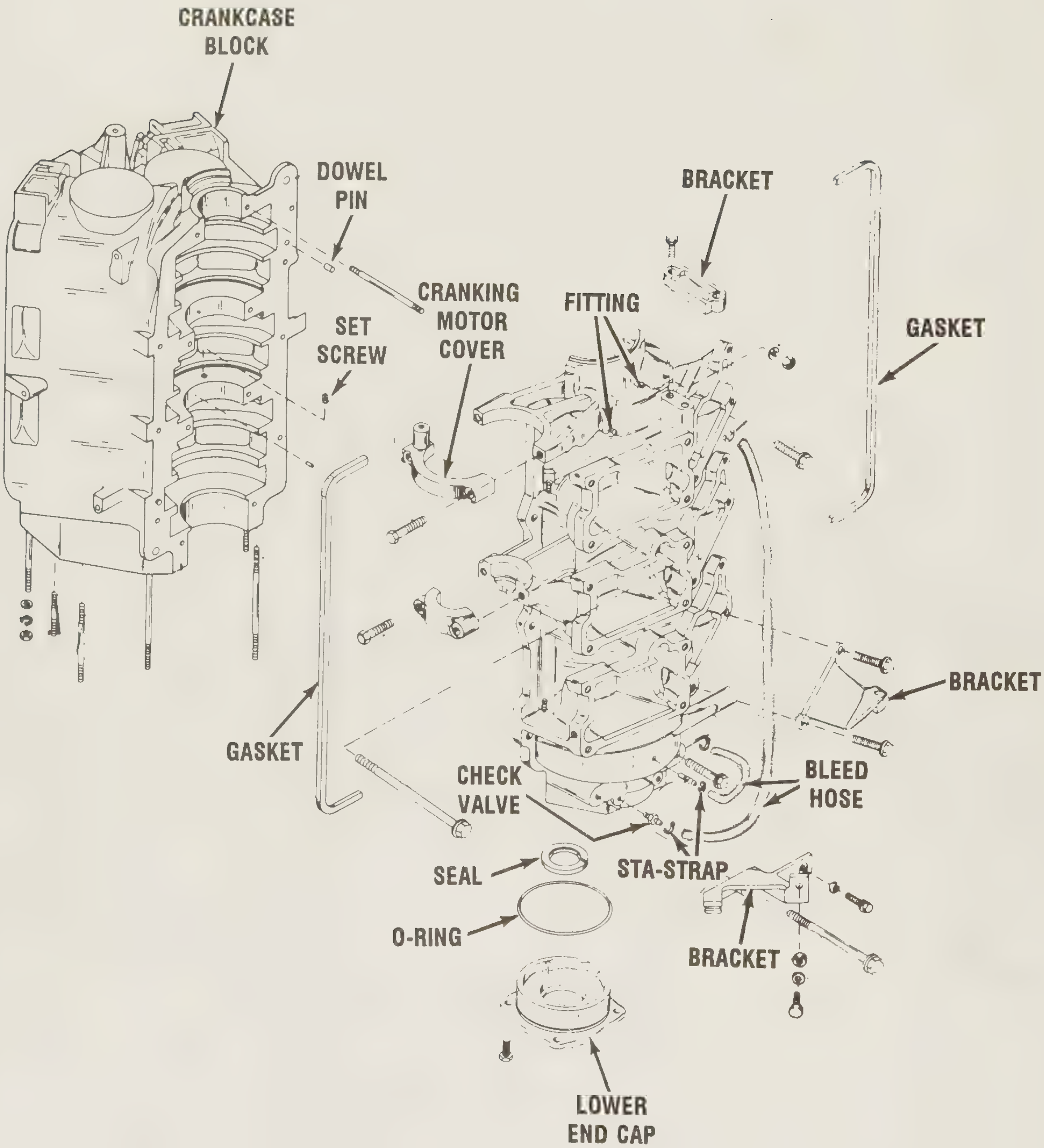
Exploded drawing of Model 135 thru 200hp crankshaft and associated parts. Powerhead units with Serial No. OD050182 and higher ***DO NOT*** *have a sealing ring installed immediately above the lower roller bearing. The crankcase block is shown on the facing page.*



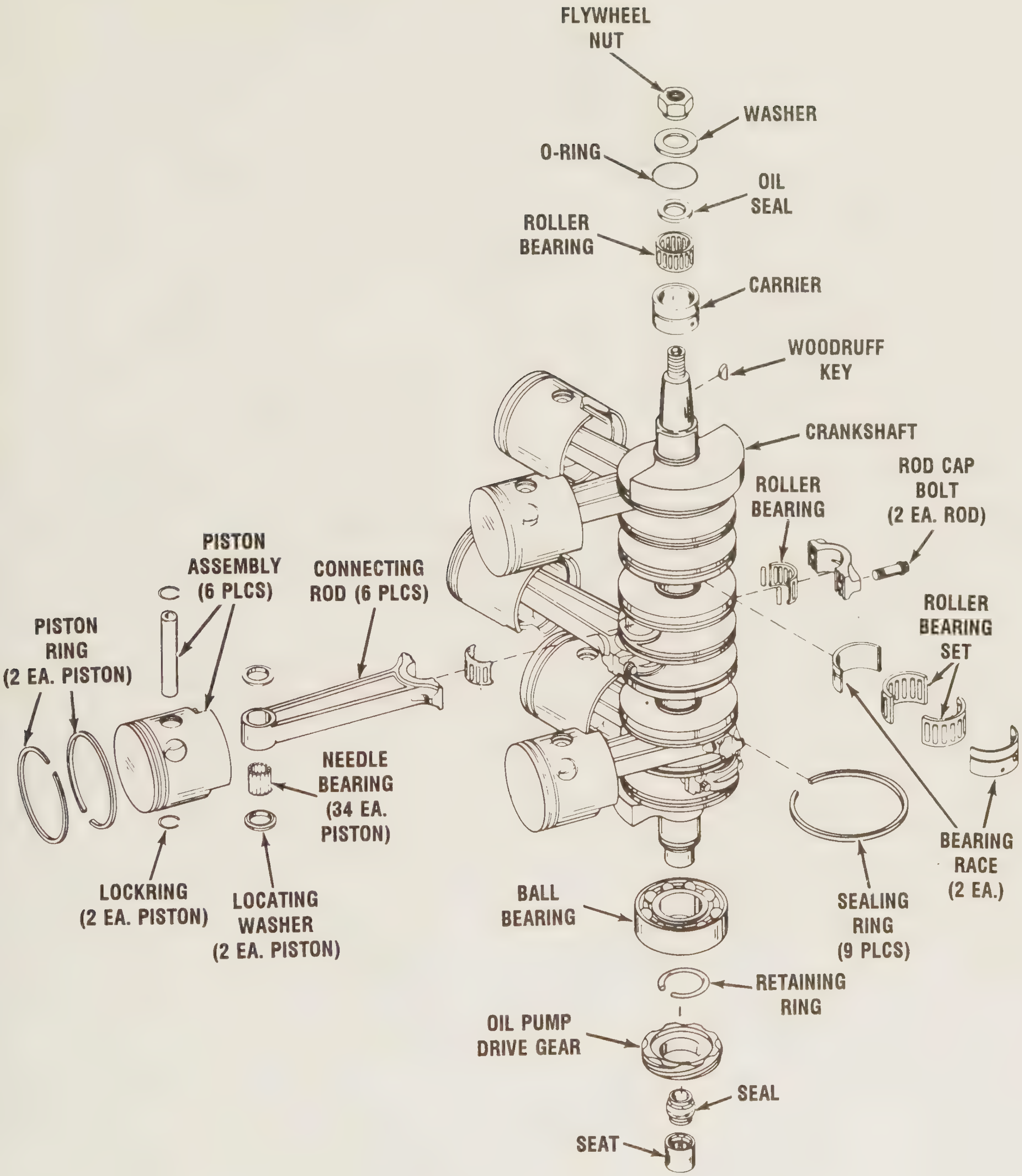
Explode drawing of Model 225hp powerhead block and associated parts. Major parts have been identified. The crankshaft is shown on the facing page.



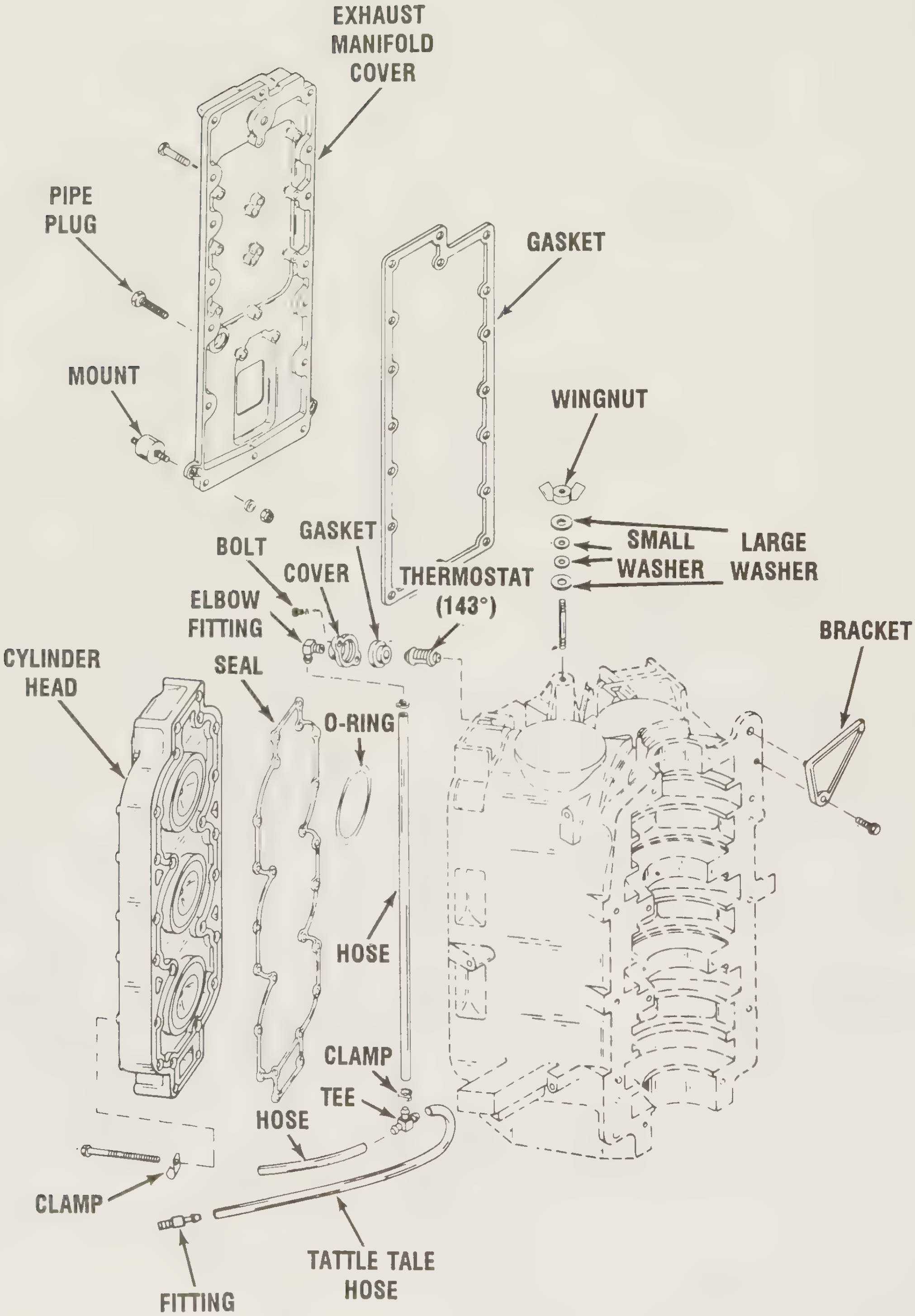
Explode drawing of Model 225hp crankshaft and associated parts. Major parts have been identified. The crankcase block is shown on the facing page.



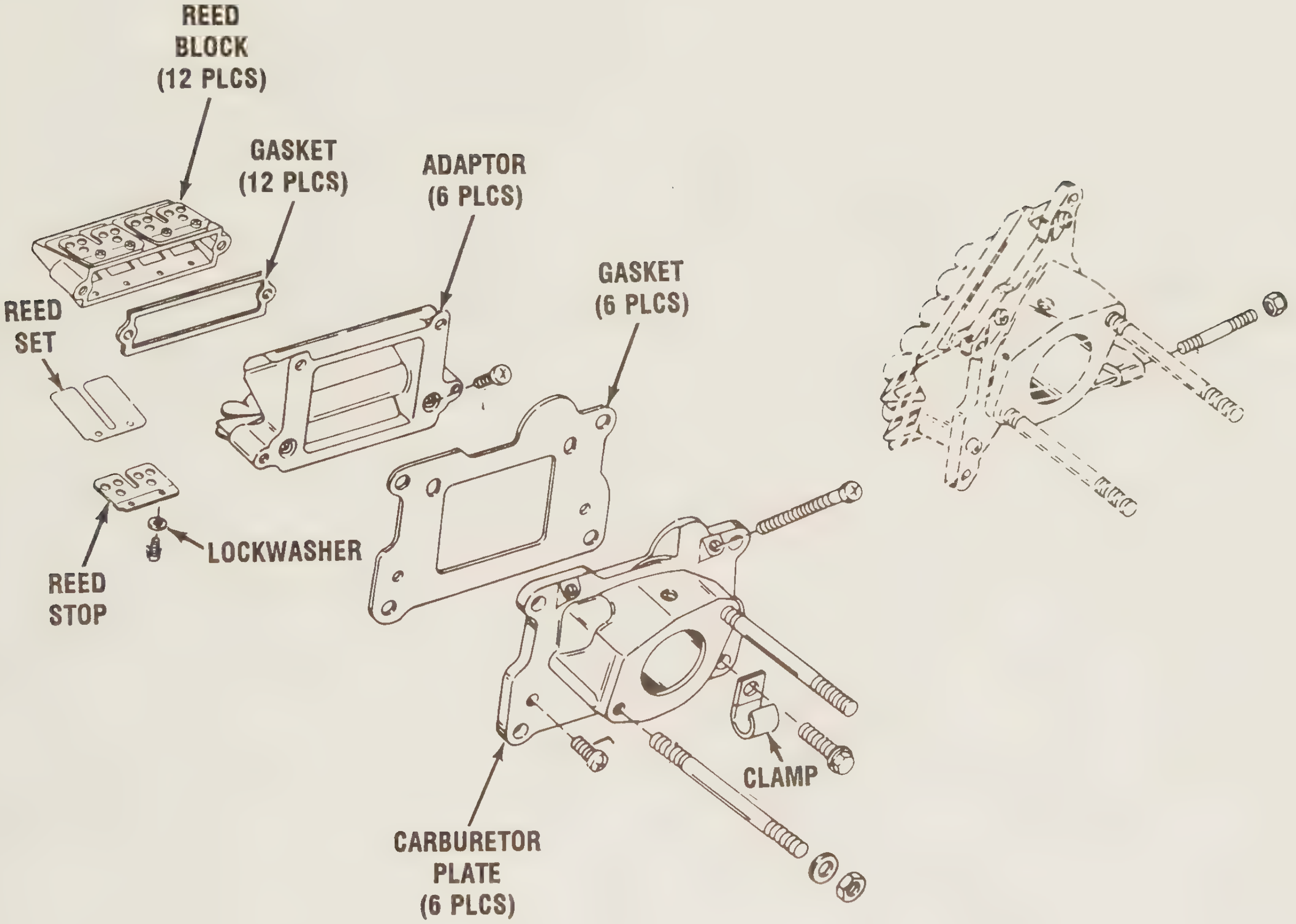
Exploded drawing of Model 275hp crankcase block and associated parts. Major parts have been identified. The crankshaft is shown on the facing page.



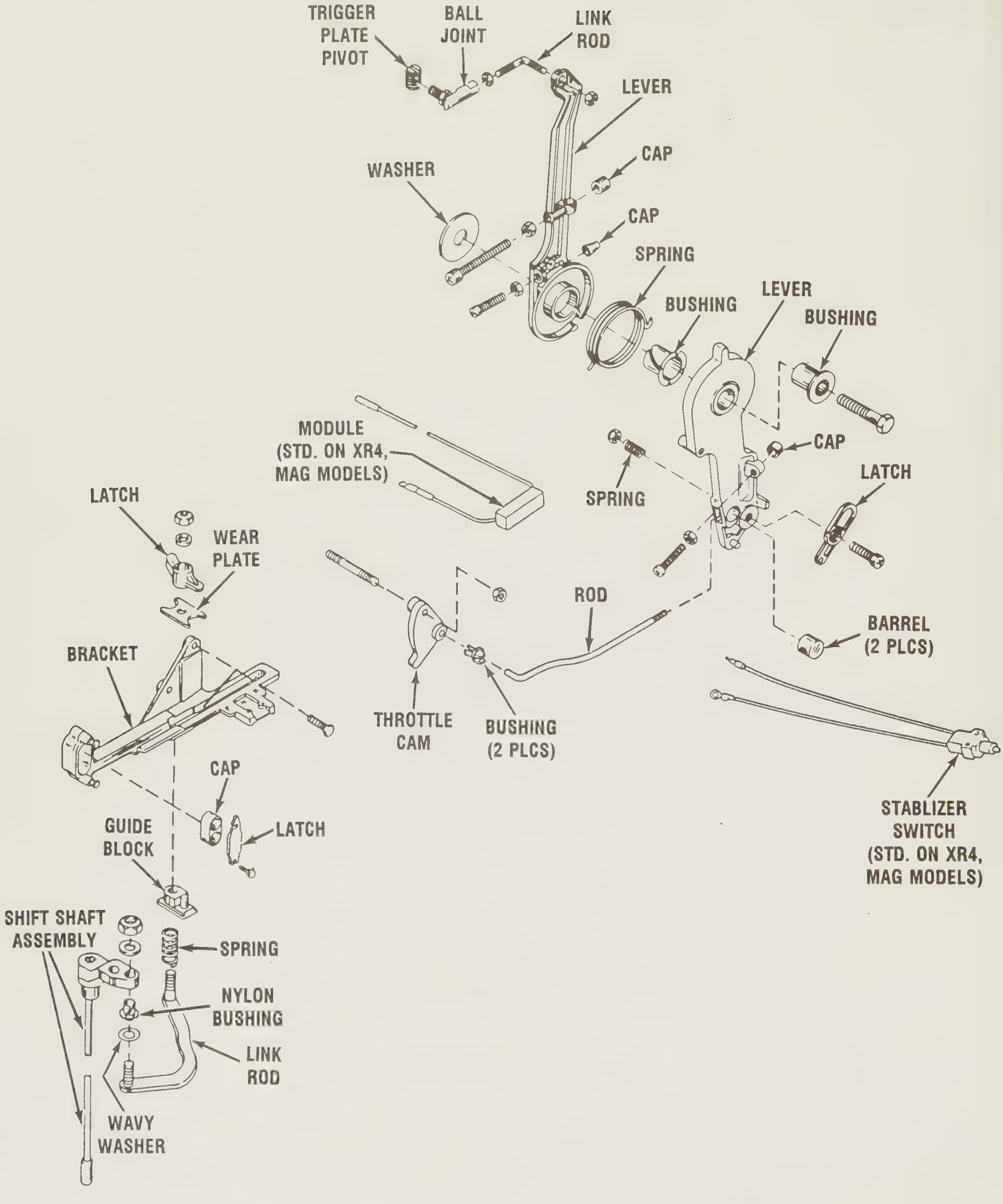
Exploded drawing of Model 275hp crankshaft and associated parts. Major parts have been identified. The crankcase block is shown on the facing page. The exhaust manifold and cylinder head is presented on the next page.



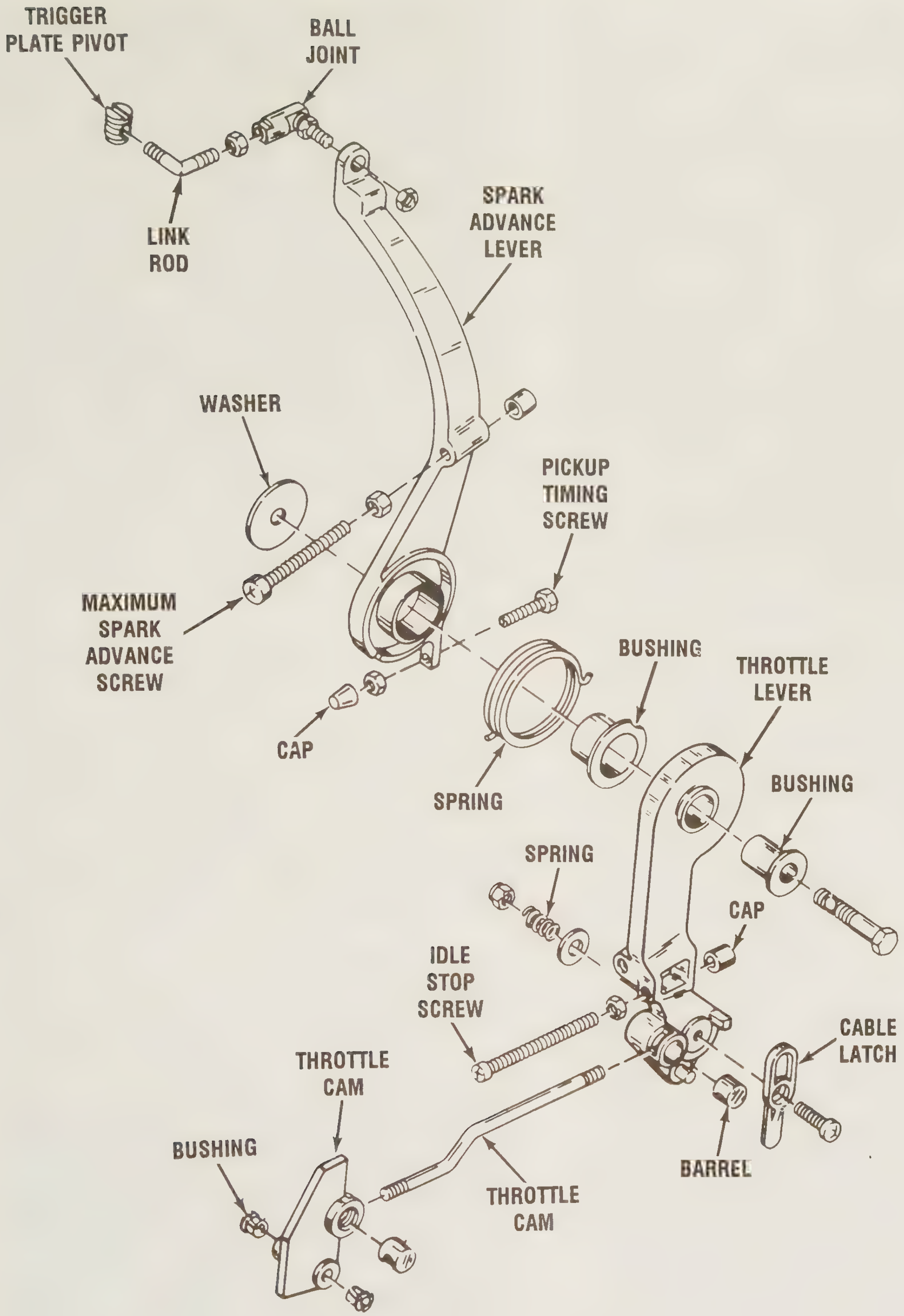
Exploded drawing of the Model 275hp exhaust manifold and cylinder head, with major parts identified. The crankcase block and crankshaft are presented on the previous two pages.



Exploded drawing of the Model 275hp reed block assembly, with major parts identified. Other parts of the 275hp powerhead are shown on the previous pages.



Exploded drawing of the Model 135 thru 225hp throttle linkage installation, with major parts identified.



Exploded drawing of the Model 275hp control arm lever, with major parts identified.

POWERHEAD ASSEMBLING

FIRST, THESE WORDS

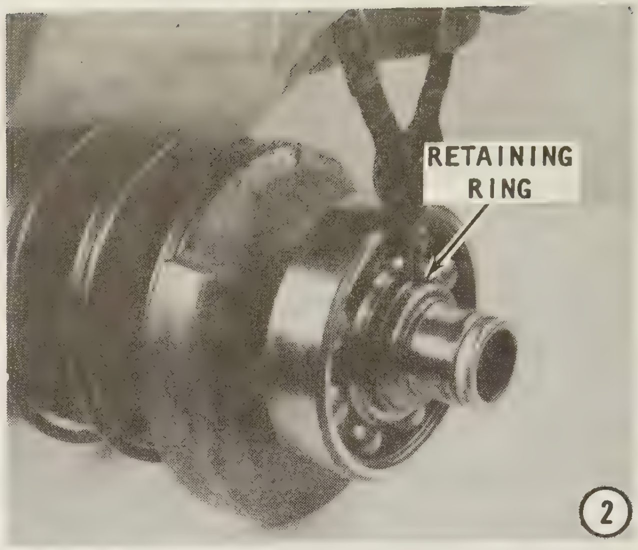
Be sure all parts to be reused have been carefully cleaned and thoroughly inspected. Parts not properly cleaned, or parts not suitable for service can damage a good powerhead within a few minutes after start up.

NEW gaskets **MUST** always be used during an overhaul.

A torque wrench is essential to correctly assemble the powerhead. **NEVER** attempt to assemble a powerhead without a torque wrench. Attaching bolts for covers and other items **MUST** be tightened to the required torque value in three progressive stages, following the specified tightening sequence. On the first stage, tighten to 1/3 the torque value. On the second stage, tighten to 2/3 the total torque value. Finally, on the third and last stage, tighten to the full torque value.

Crankshaft Assembling

1- If the ball bearing on the driveshaft end of the crankshaft was removed, install the bearing as follows: Support the crankshaft assembly in a press with the support between the counterweights and directly under the lower crankshaft end. Press the lower ball bearing onto the crankshaft, using a piece of tubing as a mandrel. **BE SURE** the tubing is the proper size so the force is only applied onto the inner race of the bearing. Continue to press the bearing into place until it is firmly seated against the



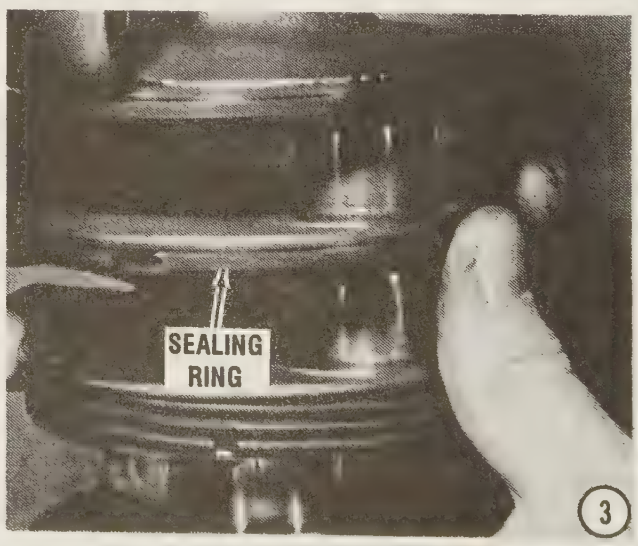
counterweight. Remove the crankshaft assembly from the press. Using a press is the preferred method as a precaution against damaging the bearing, however, an installer and hammer may be used, as shown.

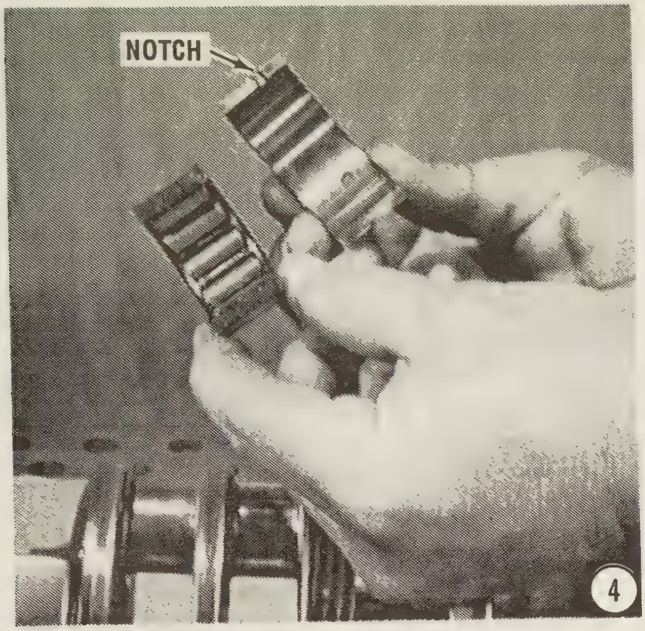
2- Use a pair of expanding type snap ring pliers and install the retaining ring to secure the lower crankshaft ball bearing in place.

3- Secure a powerhead stand in a vise, and then place the crankshaft assembly on the stand. If the crankshaft sealing ring/s were removed, spread the ring and install it around the nearest crankshaft journal. Continue, until all rings are in place. Use a piston ring expander P/N C-9124697 and install the crankshaft sealing ring into the crankshaft groove.

SPECIAL SEALING RING WORDS

On models 135 thru 200hp with serial numbers OD050182 and up, there is no sealing ring





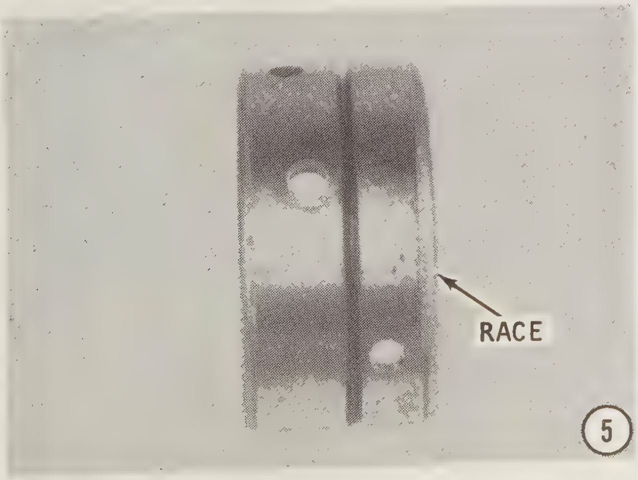
installed on the first ring groove immediately above the lower roller bearing. This groove is for installation of the oil pump drive gear.

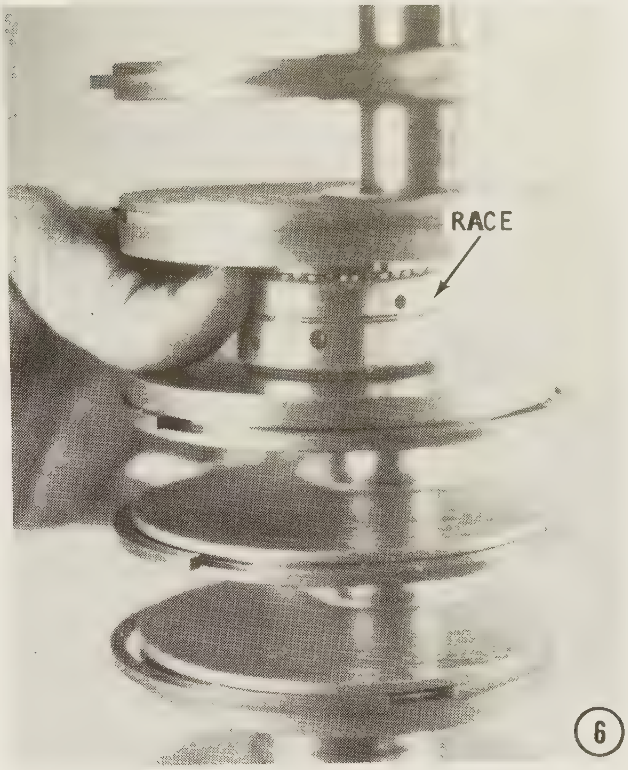
Lubricate the crankshaft sealing rings, crankshaft ball bearing, and the crankshaft main roller bearings with light weight oil.

4- Observe the notch in the main bearing journal cages. With the crankshaft in the vertical position and the flywheel end up, place the crankshaft roller bearings around the upper and lower main bearing journals with the notch in the bearing cages facing **UP.**

5- Observe the three holes in the main crankshaft roller bearing race. Notice that one hole is larger than the others. This hole is referred to as the dowel pin hole.

6- Install the bearing race halves around the main crankshaft roller bearings with the



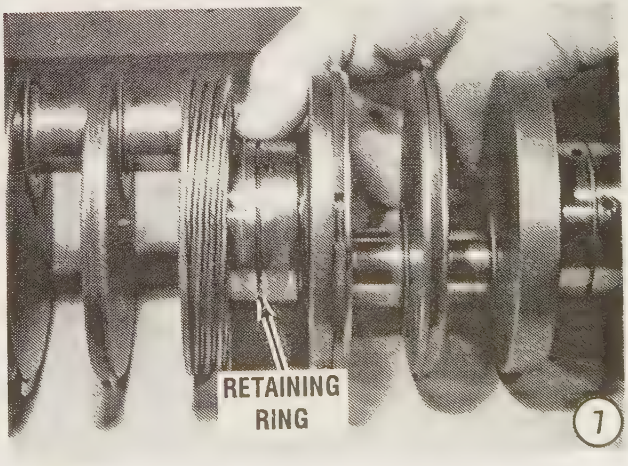


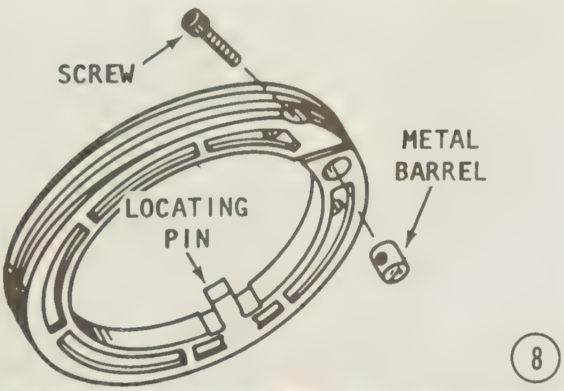
dowel pin hole **TOWARD** the driveshaft end of the crankshaft (the lower end).

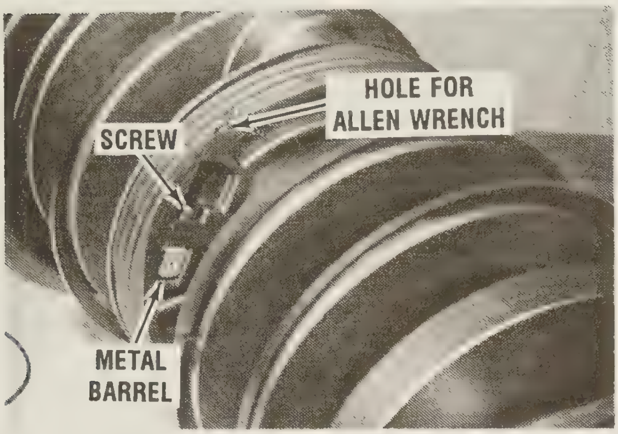
7- Secure the bearing halves in place with the retaining ring. Lubricate the crankshaft main roller bearings by injecting lightweight oil through one of the holes in the bearing race.

Oil Injection Units With One Piece Drive Gear

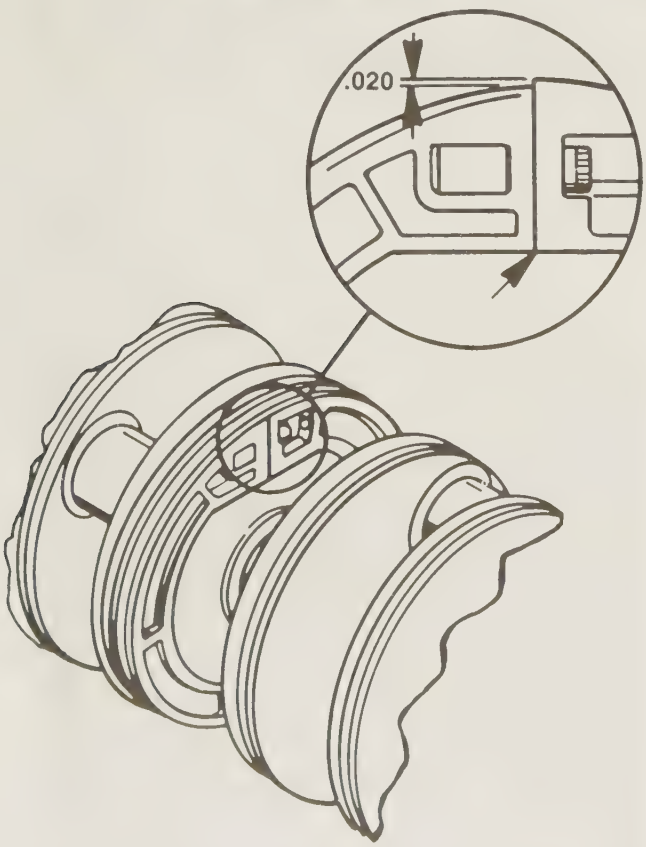
8- Soak the oil pump drive gear in hot water for approximately four minutes, until it is somewhat pliable. Separate the two ends of the gear and install the gear over the crankshaft journal next to the upper main bearing with the lip facing toward the upper end of the crankshaft. Slide the gear lip into the groove in the







Close view to show the "real world" arrangement of the oil pump gear secured to the crankshaft.



Line drawing to depict the mismatch allowed on the oil pump gear, as described in the text.

crankshaft. The locating pin **MUST** index into the crankshaft slot.

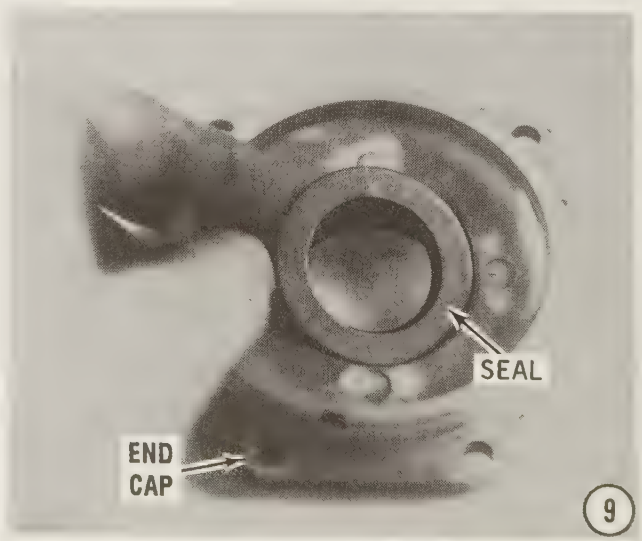
Insert the metal barrel into the center hole of the gear and align the threaded hole with the hole for the screw in the gear. Thread the screw into the hole in the gear teeth and into the metal barrel. Tighten the screw to a torque value of 8 in lbs (.9Nm). The two ends of the gear should now be tightly together and the gear mismatch at the joint line must not exceed 0.030" (.76mm). Excess mismatch will result in premature gear failure. Excess mismatch may be caused by the gear lip not being properly seated in the crankshaft groove.

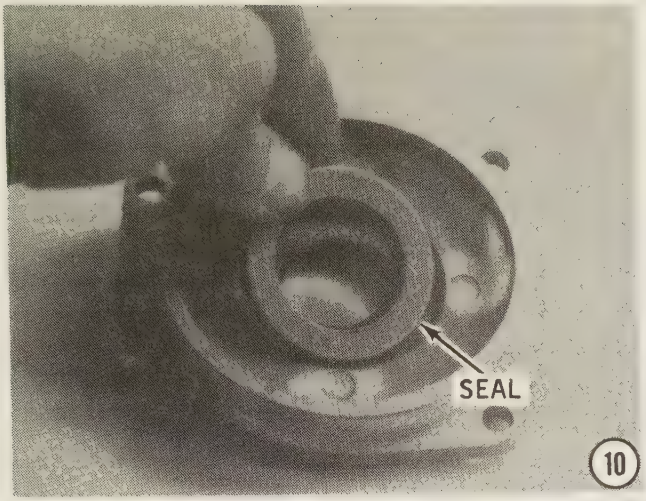
Oil Injection Units With Two Piece Drive Gear

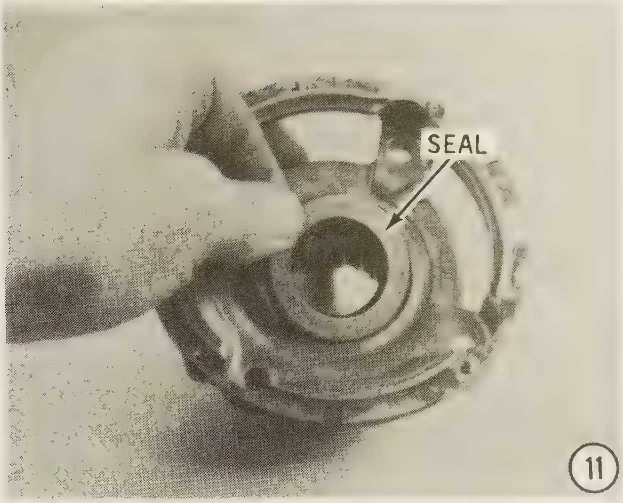
Clean and dry the threads of two **NEW** Allen head screws used to secure the oil pump drive gear to the crankshaft. Apply Locquic Primer T to the threads of both screws. Align the two gear halves with the Allen screw access holes face towards the upper main roller bearing. Apply Loctite 680 to the threads of both Allen head screws. Hold the two gear halves together, and at the same time, install the two Allen head screws. Tighten the screws to a torque value of 8 in lb. (0.9Nm). Check the gear halves split line. The clearance between the two gear halves mating surfaces should be **ZERO**, and the gear tooth mismatch **MUST** not exceed .020" (0.50mm). If the drive gear teeth are not matched correctly, loosen the two screws and re-align the gear teeth.

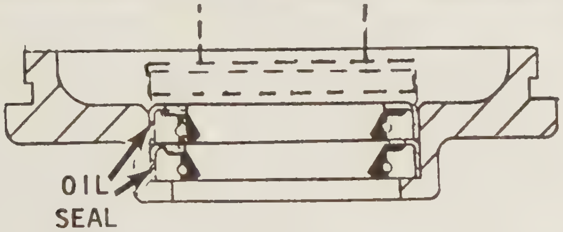
Lower End Cap Assembling

9- Lay down a thin bead of Loctite "A", or equivalent, to the outer diameter of the two lower end cap oil seals. This outer diameter is

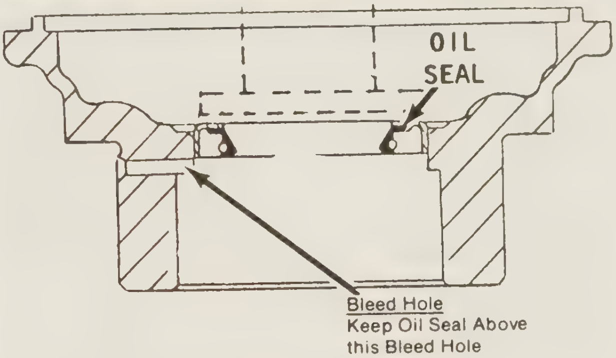








Cross section drawing to illustrate installation of the two seals in the lower end cap.



Cross section drawing to illustrate installation of the single oil seal in the upper end cap.

the area making contact with the end cap. Use Driver Head P/N C-9155919, and press one oil seal into the lower end cap with the lip of the seal **DOWN**. The lip will then be away from the cylinder block when it is installed. Continue to press the seal into place until the seal is firmly seated on the end cap shoulder. Clean away any excess Loctite.

10- Press the second oil seal into the lower end cap with the lip of the seal also **DOWN**. Continue to press the seal into place until the seal is firmly seated against the first oil seal. Clean away any excess Loctite. Lubricate the lips of the lower end cap oil seals, the surface of the end cap making contact with the cylinder block, and the lower end cap **O**-ring with light-weight oil. The larger of the two **O**-rings is used with the lower end cap. The smaller **O**-ring is used with the upper end cap and installed later in Step 12. Install the larger lubricated **O**-ring around the lower end cap.

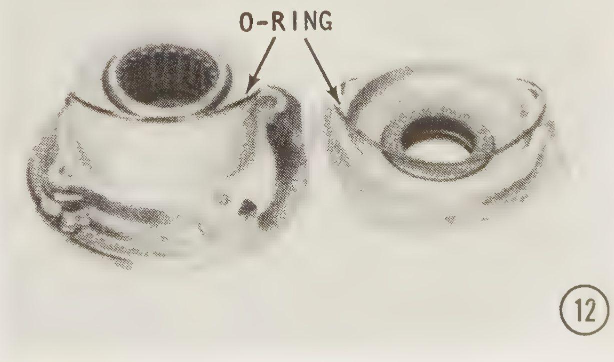
Upper End Cap

11- Lay down a thin bead of Loctite "A", or equivalent, to the outer diameter of the upper end cap oil seal. This outer diameter is the area making contact with the end cap. Use a suitable mandrel, and press the oil seal into the upper end cap with the lip of the seal **DOWN**. This position will place the lip of the seal **TOWARD** the cylinder block when installed. Continue to press the seal into place until the seal surface is flush with the surface of the end cap. Clean away any excess Loctite.

BAD NEWS

If the end cap oil seal is pressed into the upper end cap too far, the end cap bleed passage could become blocked. **TAKE TIME** to be sure the oil seal is properly installed.

12- Check the upper end cap bearing for rust, fractures, wear, galling, and discoloration



inside the end cap. If the bearing is found to be defective, both the cap and bearing **MUST** be replaced as an assembly. Apply a coating of light weight oil to the lip of the upper end cap oil seal, the end cap roller bearing, and the surface of the end cap that contacts the cylinder block. Apply a coating of light weight oil to the **O**-ring. The smaller of the two **O**-rings is used with the upper end cap. The larger **O**-ring was used with the lower end cap in Step 10. Install the lubricated **O**-ring around the upper end cap.

Lay down a clean towel on the work surface. Lay out the piston pin needle bearings in a line on the towel -- 29 by count for all except the Model 275hp and 34 by count for the 275hp.

NEVER intermix needle bearings from one piston assembly with those from another piston.

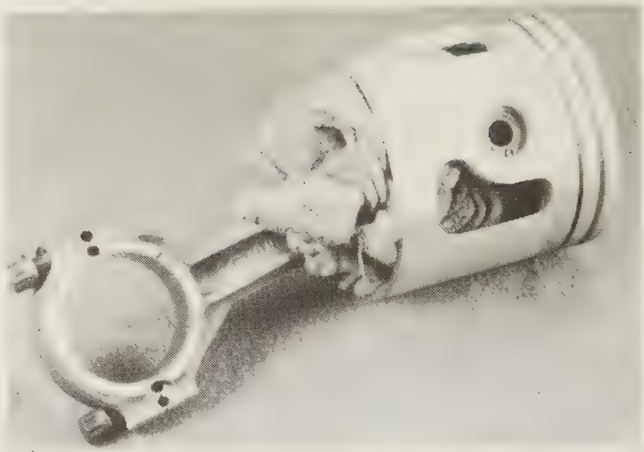
NEVER intermix used needle bearings with new bearings. If just one bearing is unfit for further service or is lost, the entire set **MUST** be replaced.

Lay down a bead of Multipurpose Lubricant onto the sleeve portion of Piston Pin Tool C-91-74607A1.

13- Always handle pistons with great care because the skirt can be bent out of round if the piston is handled roughly. Place the lower locating washer onto the piston pin tool with the shoulder on the washer toward the bearings.

To replace the piston pin and the needle bearings into the piston, first lay the needles on a clean shop cloth, as suggested in Step 12. Next, coat the sleeve portion of a piston pin installation tool with a small amount of Multipurpose Lubricant, or equivalent. If a piston pin tool is not available, a drift punch slightly smaller in diameter than the pin, may be used.

Install the retainer and the needle bearings onto the end of the tool. Leave **ONE** needle bearing **OUT**. Push the bearings and the tool into the rod piston pin bore. Now, install the last needle bearing. Place the top retainer on

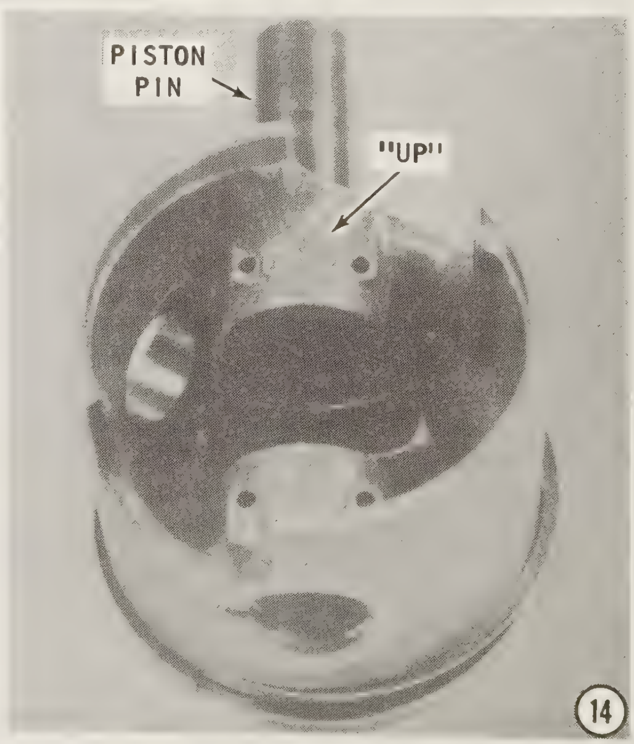


The inside of any piston should be filled with rags or shop cloths to protect the skirt from being struck by the rod while the piston is out of the cylinder.

the side of the rod. Ease the tool out of the rod, and at the same time hold onto the needle bearing retainer washer.

Once the rod and piston have been assembled, stuff a couple shop cloths inside the piston to protect the piston skirt during installation of the piston rings, and before the piston is installed into the cylinder and the rod connected to the crankshaft. If the skirt should accidently be struck by the rod while the piston is being handled out of the cylinder, a slight distortion might be caused to skirt.

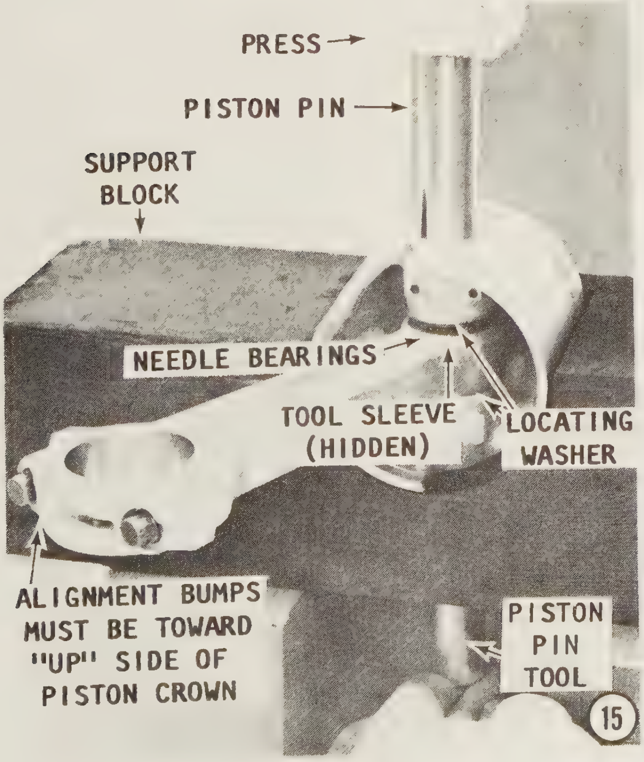
14- Notice the word **"UP"** on the piston pin boss inside the piston skirt. This word indicates the side of the piston that **MUST**



face upward, toward the top of the engine, when it is installed. The **"UP"** side of the piston **MUST** face downward on the support block when the piston pin is pressed in. Place the piston in a container of hot water, approximatley 190°F. Leave the piston in the hot water, ready for installation later in Step 24. The piston may also be heated with a heat lamp to approximately 190°F.

15- In an arbor press, place the heated piston, per Step 13, in position on the Piston Support Block, C-91-77005, with the side marked **"UP"** on the piston pin boss down against the block. Use one hand to hold the sleeve, bearings, and locating washers in place. At the same time, with the other hand, insert the connecting rod into position in the piston, with the two bumps on the crankshaft end of the rod **TOWARD** the word **"UP"** on the piston. Once the rod is in place, slide the handle portion of the piston pin tool up through the hole in the support block and on through the lower piston pin boss into the sleeve.

Hold the piston pin needle bearings in place with the piston pin tool, and press the piston pin into position as far as possible with the arbor press. Use the piston pin tool between the arbor press and the piston pin to position the piston pin the rest of the way into the piston.



SAFETY WORD

Wear eye protection glasses while installing the piston pin lockrings, because the lockrings are made of spring steel and may slip out of the tool or pop out of the groove with considerable force. **DO NOT** use a lockring the second time. Use new lockrings and check to be sure they are properly seated in the piston grooves.

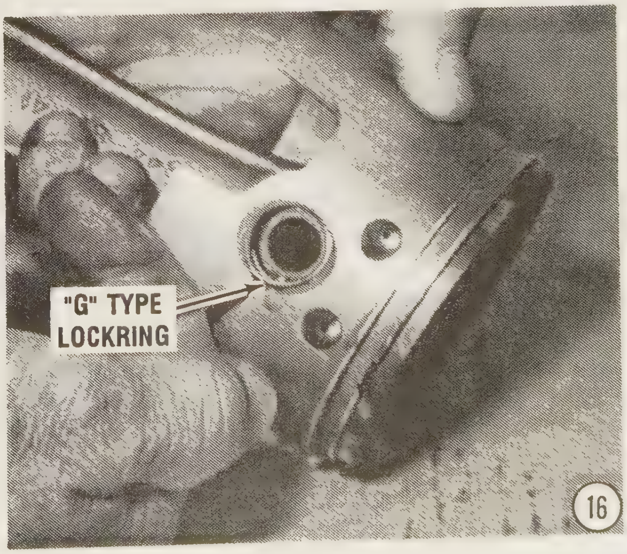
16- Install a G-type piston pin lockring at each end of the piston pin using Lockring Installation Tool, C-91-77109A1, or a pair of needle-nose pliers. Check and double check, to be sure each lockring is properly seated in the piston groove.

RING AND PISTON EXPLANATION

This step does not involve any action with tools or equipment. However, these words must be **READ** and **UNDERSTOOD** before beginning the ring installation work. Mercury and Mariner V6 powerheads are in a constant state of change, due to improved materials and engineering design. As a result, four different type piston rings have been used, as described in the following paragraphs and shown in the illustrations on Pages 8-25 and 8-26

Tapered and Rectangular Rings

All 135 and 150hp models with a 122 cubic inch powerhead and all 275hp models with a 207 cubic inch powerhead have a tapered and rectangular ring set installed on the pistons. The upper ring is a tapered Keystone ring while the lower ring is a standard rectangular ring. **BE SURE** to install the tapered ring into the top ring groove and the rectangular ring into



the bottom ring groove. Be sure the **DOT** on each ring is facing **UP, TOWARD** the crown or top of the piston.

Dual Keystone Rings

All Model 150 and 175hp units with a 142.2 cubic inch powerhead use two rings of the same style. Both are Keystone tapered rings. The only critical part of the installation procedure is to be sure the **DOT** on the side of each ring is facing **UP, TOWARDS** the piston crown. Installation procedures are the same for standard Mercury and Mariner pistons.

Half Taper Keystone Rings

All Model 150, 175 and 200hp -- 1993 and on -- use a **NEW** style ring. This new ring, classified as a "half taper" Keystone ring, is flat on the bottom side with the taper on the top or "**UP**" side of the ring. Both rings are identical and may be installed into either groove of the piston. The **DOT** on the side of each ring **MUST** face **UP, TOWARDS** the piston crown. Installation procedures are the same for standard Mercury and Mariner pistons.

Oversize Pistons and Rings

All oversize pistons for Model 135 thru 200hp V6 powerheads are manufactured to use two Keystone, tapered, rings. As with other pistons using Keystone rings, the only critical procedure during installation is to be sure the dot on the side of the ring faces **UP, TOWARDS** the piston crown.

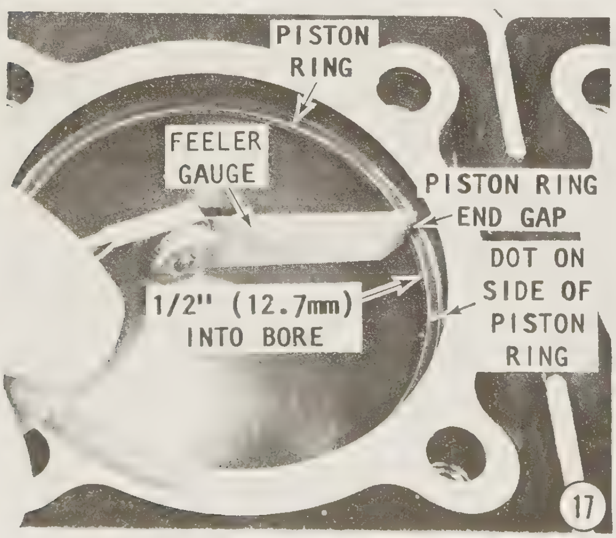
Ring Check In The Bore

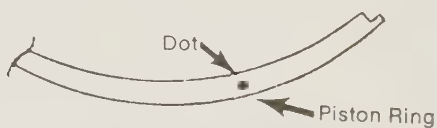
17- Insert each new ring, one at a time, into the cylinder bore to which the piston will be installed. Move the ring down about 1/2" (12.7mm) using a piston to ensure the ring is positioned properly -- at a right angle to the cylinder wall. With the ring in this position, use a feeler gauge and measure the end gap of the ring -- the distance between the ends when the ring is installed. The acceptable limits for the ring gap by powerhead size is as follows:

Powerhead Cubic Inch (Model hp)	Ring End Gap
122 (135/150hp)	0.018" - 0.025" (0.45mm - 0.64mm)
142 (175hp)	0.018" - 0.025" (0.45mm - 0.64mm)
153 (200hp)	0.018" - 0.025" (0.45mm - 0.64mm)
185 (225hp)	0.010" - 0.018" (0.25mm - 0.45mm)
207 (275hp)	0.012" - 0.024" (0.30mm - 0.61mm)

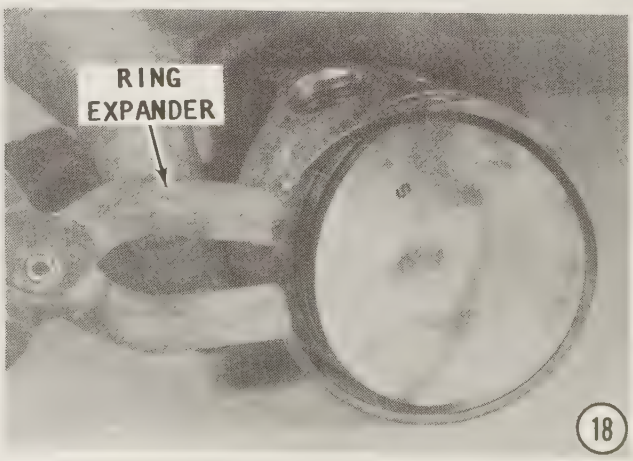
Repeat this procedure for all piston rings. Insert each ring into the proper cylinder using the numbered piston the ring will be installed onto.

If the gap is greater, check other new rings in the cylinder bore until a ring within the





*Piston ring side with the dot **MUST** face **UP**.*



designated tolerance is found. If the end gap is less than the specified tolerance, and another ring with tolerance cannot be found, it may be necessary to file some of the material from the ring end in order to meet the required tolerance.

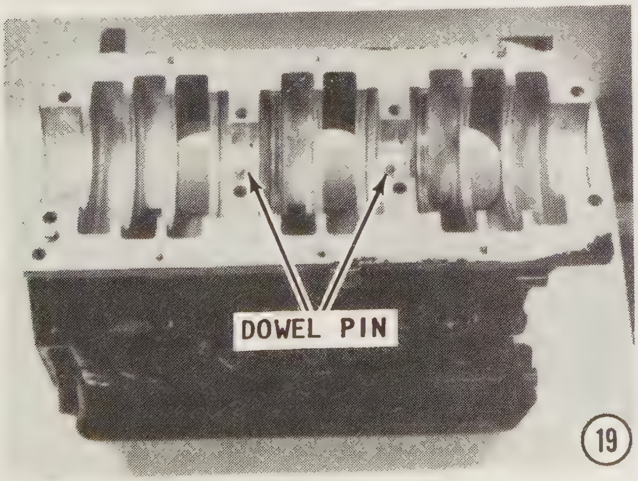
18- Use a ring expander and install the ring set identified for the No. 1 piston and cylinder into the piston ring groove. Adjust the ring expander in small increments until the ring will just barely fit over the top of the piston. If the expander is adjusted to open the ring more than necessary, the ring may break. Work **SLOWLY**, and check each ring to be sure it is installed properly with the dot on the side of the ring facing **UP, TOWARDS** the piston crown **AND** the ring is in the proper ring groove for the type piston being installed. Check the paragraphs following Step 16 for the correct rings to be installed on the 2-ring pistons used in the powerheads covered in this manual.

After the rings are in place, attempt to rotate the ring in its groove. The attempt **MUST FAIL.** If the ring is free to rotate, the locating pin is not performing its function and the piston must be replaced.

Lubricate the piston, the rings, and the cylinder bore with a good grade of 50-weight oil. Lay the assembled piston aside, ready for later installation.

CRANKSHAFT INSTALLATION

19- Cover the work surface with a clean towel. Lay the powerhead on the towel with the crankshaft side up and the top of the powerhead to your **LEFT**. In this position, the cylinder bores closest to you are No. 1, No. 3, and No. 5 in the port bank. The cylinder bores on the far side of the block are No. 2, No. 4,



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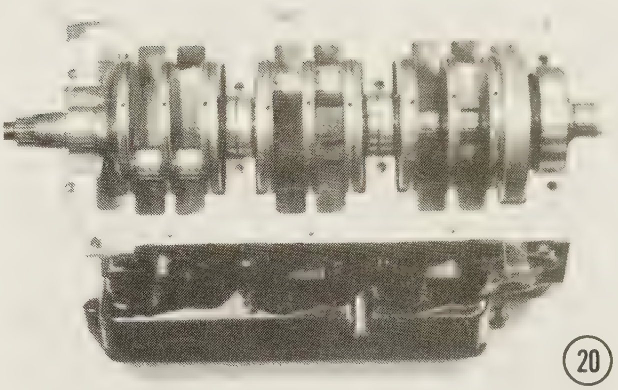

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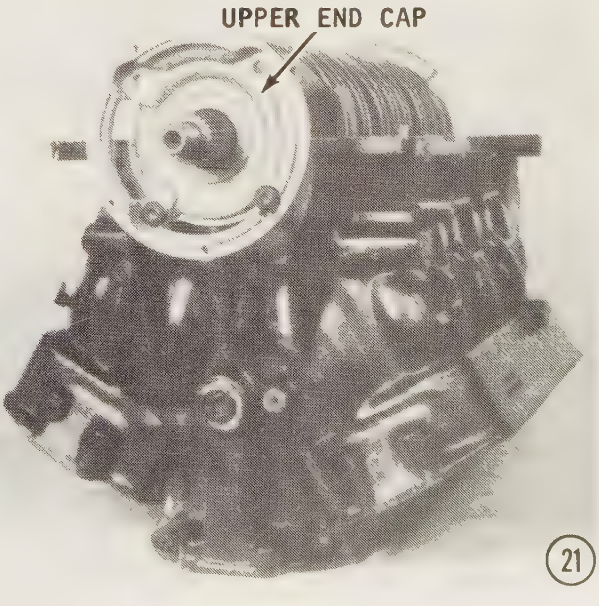
and No. 6 in the starboard bank. Check the cylinder block to be sure the crankshaft main bearing dowel pins are in place. If they are not in place, install **NEW** pins.

20- Rotate the crankshaft seal rings until the ring gap of each ring is straight up. Lower the crankshaft assembly into the cylinder block, with the flywheel end toward the top of the powerhead. The top of the powerhead is still to your **LEFT.** Gently push the crankshaft down into position. Position each bearing race until the center of the dowel pin hole is aligned with the edge of the cylinder block. Now, use a grease pencil and make a mark exactly at the top of each bearing race. Next, rotate each bearing race until the grease pencil mark is aligned with the edge of the cylinder block. The dowel pin hole of each race will now be very close to the dowel pin in the block. Push down on the crankshaft and at the same time, if necessary, rotate the main bearing races very slightly, until the dowel



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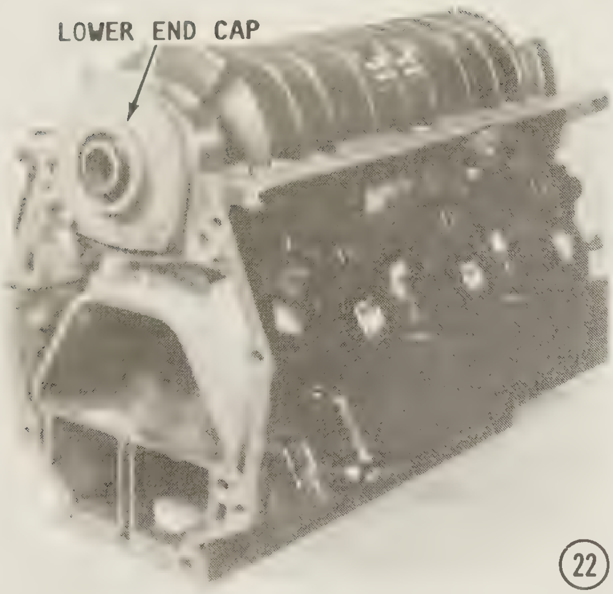

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pin hole in each race indexes the dowel pins in the block. Compress the crankshaft seal rings with your fingers and, at the same time, push the crankshaft downward until it is fully seated in the cylinder block.

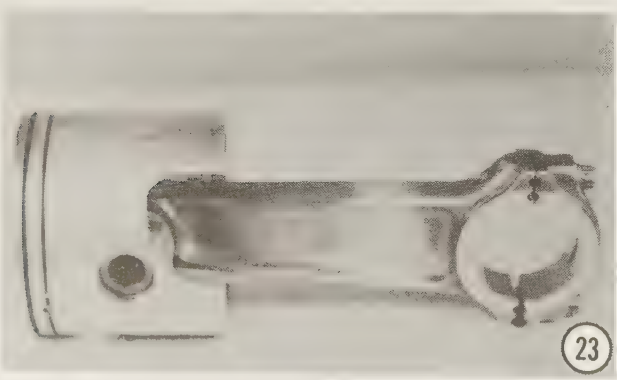
21- Lubricate the oil seal areas of the top upper crankshaft end with light weight oil. Install the upper end cap and hold it in place with the attaching bolts. **DO NOT** tighten the bolts at this time.

22- Lubricate the oil seal area of the lower crankshaft end with light weight oil. Install the lower end cap and hold it in place with the attaching bolts. **DO NOT** tighten the bolts at this time.

23- Check to be sure the number scribed onto the connecting rod during disassembly matches the cylinder number into which the piston assembly is to be installed. Use the marine ring compressor and install the pistons one at a time into their designated cylinder bores. If a marine ring compressor is not available, a suitable size hose clamp, a Volkswagen type ring compressor, or an automotive type compressor may be used. Use of the automotive-type compressor is the **LEAST** desirable because, as the compressor is tightened, the rings will rotate and the ring gap will not remain at the locating pin. The procedures for using the hose clamp are outlined in Step 25. Use of the Volkswagen compressor in Step 27, and the automotive type compressor in Step 28.

24- **OBSERVE** the identification marks on the crown of each piston. On the crown, the letter **"S"** indicates the piston **MUST** be installed in cylinder No. 1, 3, or 5 of the starboard bank. The letter **"P"** indicates the piston **MUST** be installed in cylinder No. 2, 4, or 6 of the port bank.

Some piston sets have the word **UP** embossed on the crown, as shown in the accompanying illustration. This word indicates the side of the piston that **MUST** face upward, toward the top, the flywheel end, of the powerhead when it is installed. This position will place the large hole in the piston



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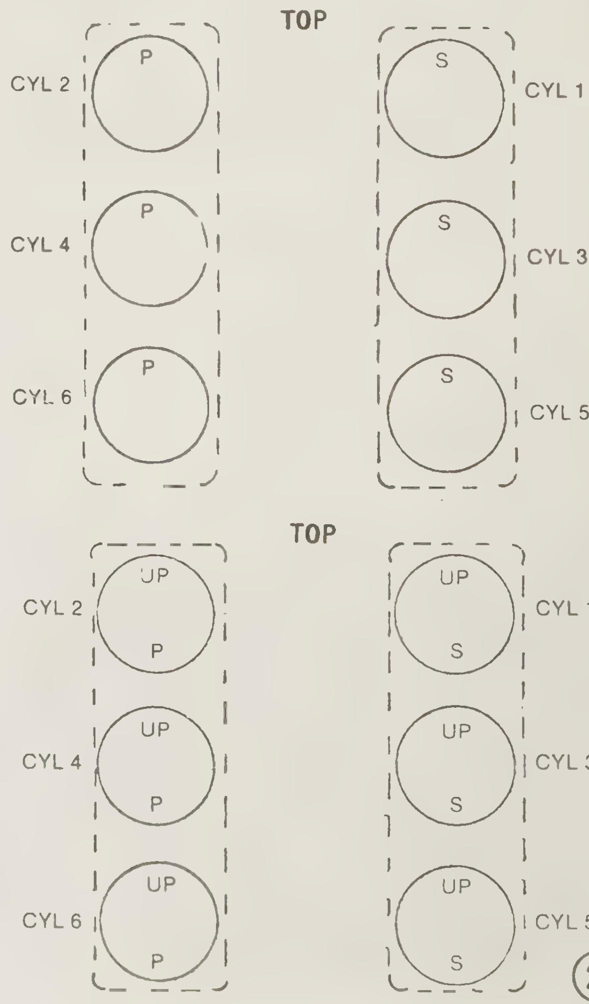

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skirt directly opposite the exhaust port in the cylinder wall.

Lubricate the piston rings, piston skirt, piston pin needle bearings, and the respective cylinder wall with light weight oil. Rotate each piston ring in the piston groove until the open ring gap is positioned at the pin in the groove.

CRITICAL WORDS

The ring **MUST** be positioned as just stated or the ring will be **BROKEN** when the ring compressor is installed, or when the piston is inserted into the cylinder bore.

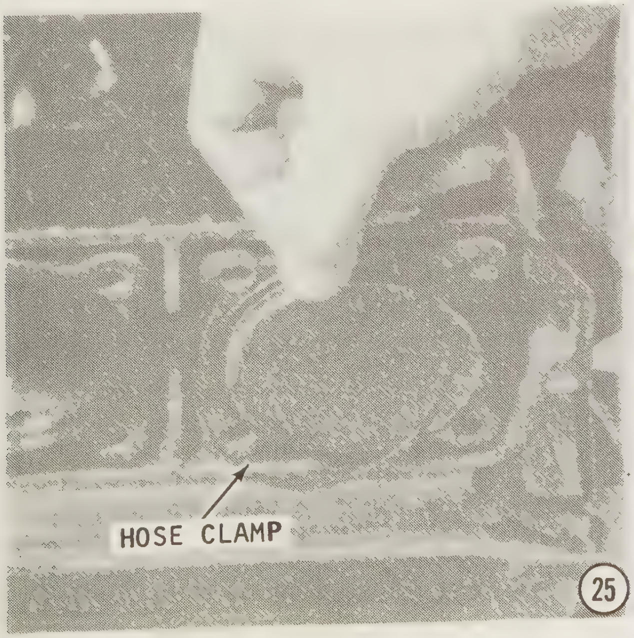
PROCEDURE: Install one piston using the procedures outlined in Step 25 and 26, **OR** 27, **OR** 28, depending on the type of ring compressor being used, then move to Steps 29 thru 33. Repeat the steps for each piston and rod until all six are installed.

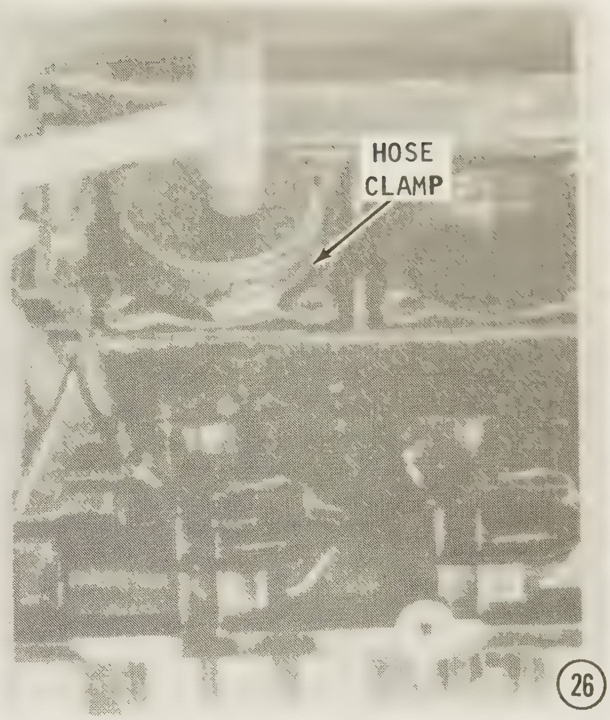
Ring Installation Using Hose Clamp Units With 74° Block

25- If a standard marine type ring compressor is not available, install the rings onto the piston and the piston into the cylinder bore as follows: Install **ONLY** the lower ring onto the piston. Tighten the hose clamp over the ring and at the same time, rotate the ring until the ring gap is at the locating pin in the piston groove. Remove the rod cap from the rod.

CRITICAL WORDS

Install the piston into the cylinder bore in the correct position as indicated in the previous step.





Gently tap the piston into the cylinder with the wooden handle of a tool until the ring enters the bore. Remove the hose clamp.

26- Install the next ring into the piston groove. Install the hose clamp and at the same time rotate the ring until the ring gap is at the locating pin in the groove. Tighten the hose clamp and tap the piston into the bore until the ring enters the bore. Align the connecting rod with the cylinder block opening, and then push on the piston crown until the piston is installed into the bore. Remove the hose clamp. Skip to Step No. 29.

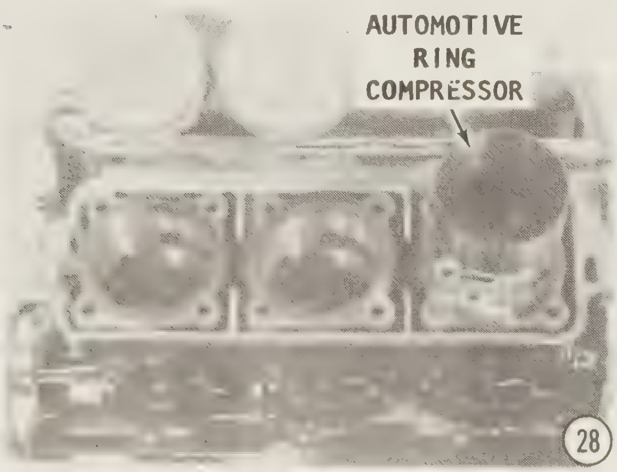
Ring Installation Using Volkswagen Type Ring Compressor

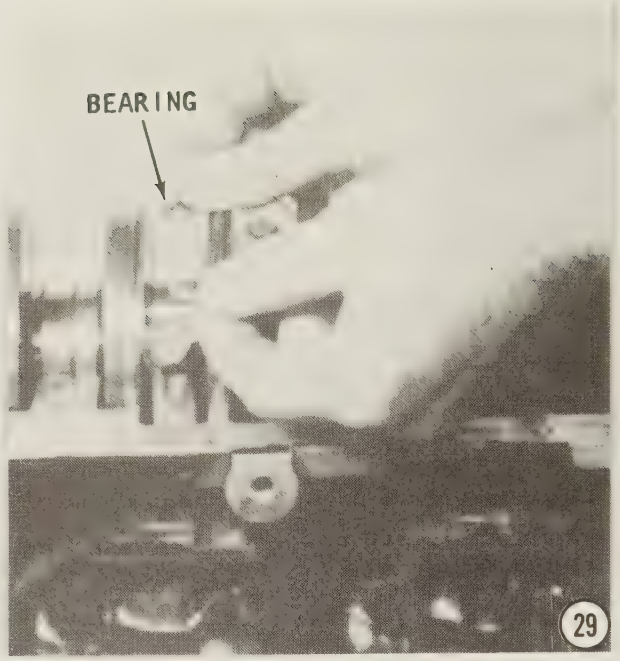
27- After all rings have been properly installed onto the piston, position the Volkswagen type ring compressor band around the rings on the piston. Now, using the ring compressor pliers, squeeze the band together, and at the same time, rotate the piston back-and-forth to be sure the ring ends remain between the piston dowel pins. Once the compressor band is snug against the piston, remove the rod cap from the rod and install the piston into the cylinder bore. Align the connecting rod with the cylinder block opening, and then push on the piston crown

until the piston is installed in the bore. When utilizing this method of piston installation, you may now skip to Step 29.

Ring Installation Using Automotive Type Ring Compressor

28- As explained earlier, an automotive-type ring compressor should **ONLY** be used as a last resort when no other method is possible. The reasoning is: as the ring compressor is tightened, the rings will rotate and the ring gap will not remain at the locating pin. To use this type of ring compressor for a marine application: after the rings have been properly installed as outlined in Step 18, position the compressor over the rings and begin to tighten the band.





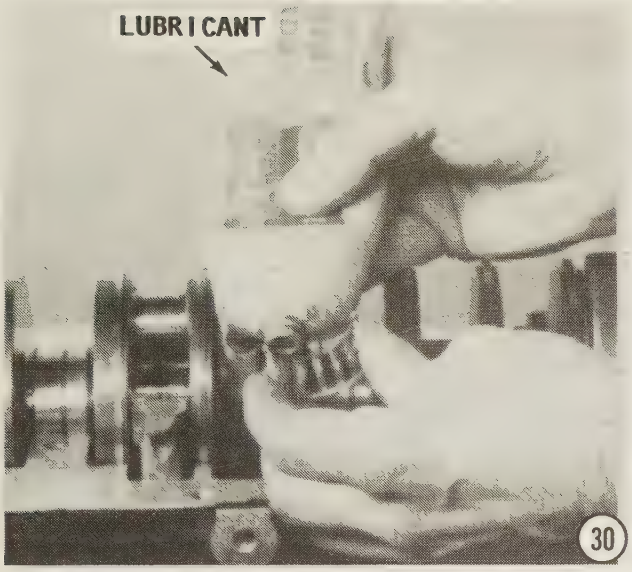
As the band is tightened, rotate the piston back-and-forth to ensure the ends of the rings remain in position between the piston locating pin. Align the connecting rod with the cylinder block opening, and then push on the piston crown until the piston is installed into the bore.

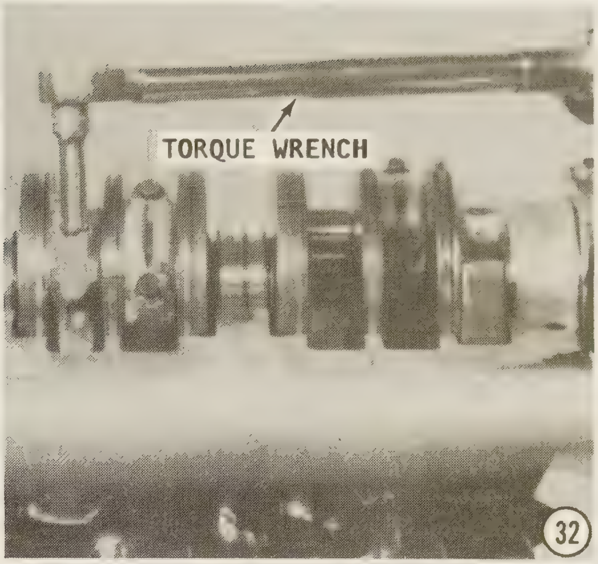
Installing Rods To Crankshaft

29- Bear in mind, the cylinder bores closest to you are still No. 1, 3, and 5 in the starboard bank. The flywheel end, top, of the powerhead is still to your **LEFT.** Begin with the No. 1 rod, the rod to the far left. Apply a coating of Multipurpose Lubricant to the bearing surface of the connecting rod, and then install the bearing cage and the roller bearings into the lubricant. **NEVER** intermix roller bearings from one connecting rod cage with those from another rod cage. **NEVER** intermix used roller bearings with new bearings. If just one bearing is unfit for service or is lost, the entire set **MUST** be replaced. Move the connecting rod up to the crankshaft journal.

After the rod is in position on the crankshaft, install one needle bearing on each side of the crankshaft in the end of the needle bearing cage, as shown.

30- Apply a coating of Multipurpose Lubricant to the crankshaft journal. Install the other bearing cage and the remaining roller bearings into the lubricant. Clean the



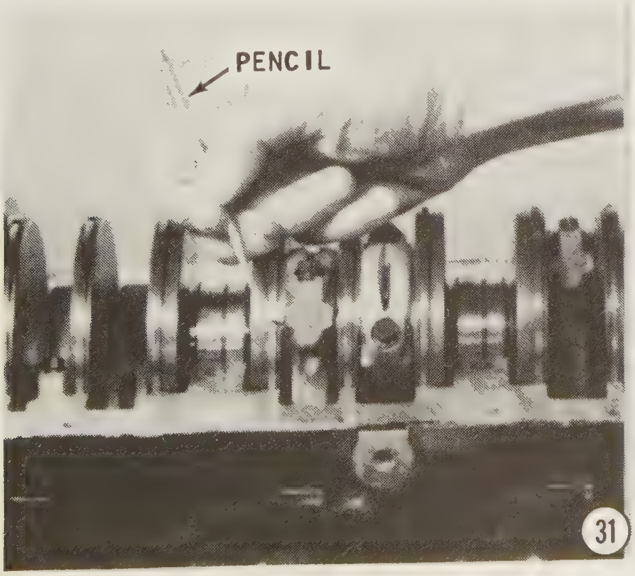


connecting rod bolts with solvent, and then blow them dry with compressed air.

31- On Models 135 thru 225hp, coat the threads of the rod bolts with light weight oil. On Model 275hp, apply a drop of Loctite Type "A", or equivalent, to the threads of each connecting rod bolt. Place the rod cap in position with the marks (bumps and etch marks), on the connecting rod and cap aligned. Install the rod bolts and tighten fingertight.

Check the alignment between the rod cap and the rod by moving a pencil point back and forth on the chamfered corners between the rod cap and rod. If a ridge is felt, the rod cap is not aligned properly. The cap **MUST** be aligned before proceeding.

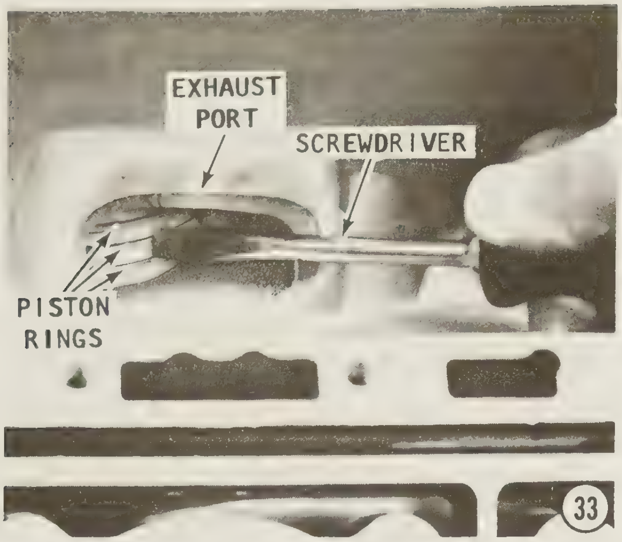
32- Use a 5/16", 12-point socket, (3/8" socket for model 275), and tighten the rod bolts alternately in three progressive stages. First stage -- tighten to 15 in lb (1.7Nm), and check the rod



cap alignment. Second stage -- tighten to 30 ft lb, (40.7Nm), and again check the rod cap alignment. The third and final torque stage -- tighten the rod bolts an additional 90^0 (1/4 of a turn). Once again, check the alignment between the cap and the rod.

Check to be sure all of the roller bearings have been properly installed. This can be done by inserting a small tool through the slot in the connecting rod cap and rotating the cage. **TAKE CARE** not to scratch the bearings. Install the remaining pistons, rods, and rod caps, one at a time, **IN ORDER** by repeating Steps 25 thru 31, completely for each piston before proceeding to the next. Work each rod onto the next crankshaft connecting rod journal, **WITHOUT** skipping a rod or journal. Continue until all pistons have been properly installed.

33- Check to be sure each piston ring has spring tension. This is accomplished by **CAREFULLY** pressing on each ring with a screwdriver extended through the intake ports. If spring tension cannot be felt (the spring fails to return to its original position) the ring was probably broken during the piston installation process. **TAKE CARE** not to burr the piston rings while checking for spring tension. Thread the flywheel nut onto the end of the crankshaft. Rotate the crankshaft several times with a wrench on the nut and check the installation work thus far. The crankshaft should turn freely with no indication of binding or "rough" spots. Leave the flywheel nut on the crankshaft, because it will be used again before the flywheel is installed.



Crankcase Cover Installation

34- Before mating the crankcase cover and the cylinder block, check to be sure:

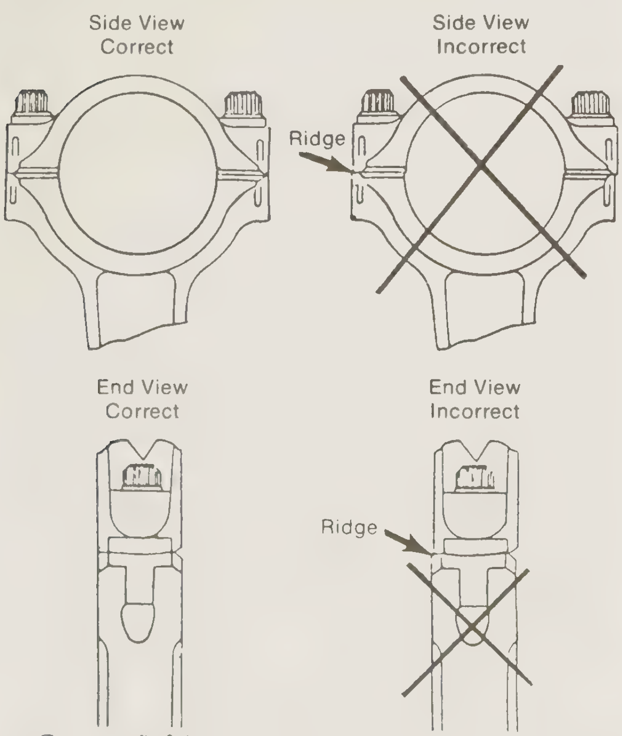
a- The mating surfaces are clean. **NEVER** use any kink of tool or abrasive material to clean the surfaces. Use only solvent and "elbow grease".

b- The crankshaft is properly seated.

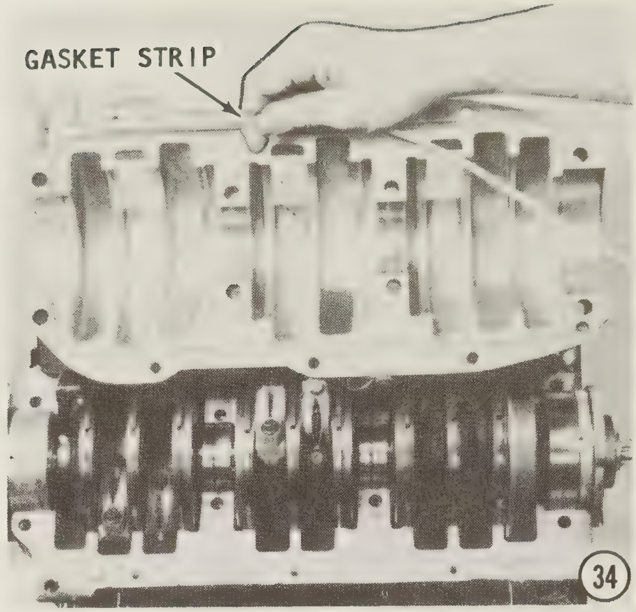
c- The rod caps have been correctly installed.

CRITICAL WORDS

Take time to roll the **O**-rings of both end caps outward to permit the crankcase cover to seat.



Correct (left) and incorrect (right) rod cap alignment. A ridge can be seen or felt if incorrect.



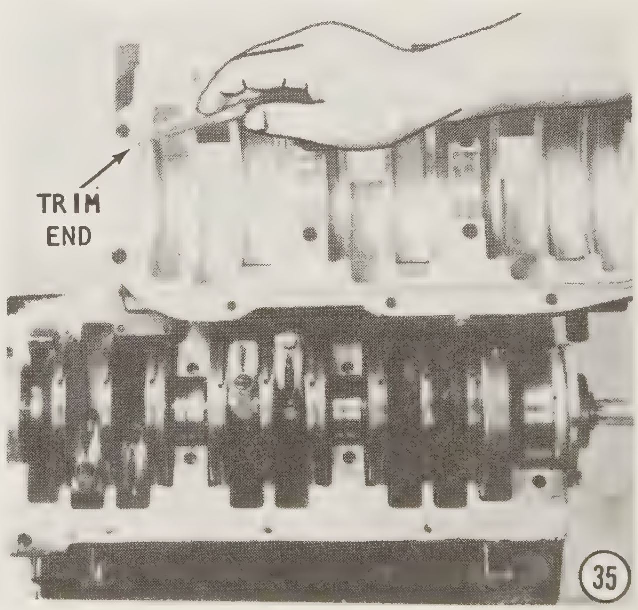
Install gasket strips into the grooves in the crankcase cover.

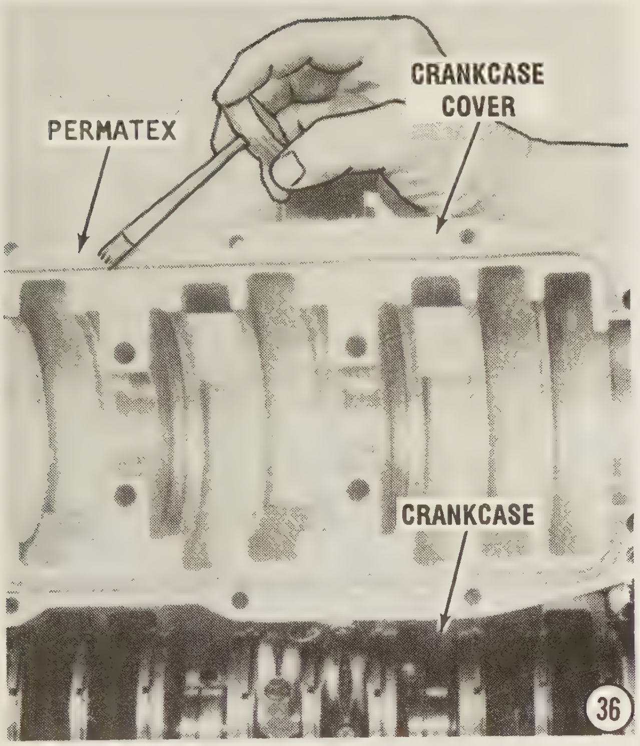
35- Trim the end of each gasket strip flush with the edge of the cover.

36- Apply a coating of Permatex 2C-12 to the gasket strips and the gasket contact surface of the crankcase cover prior to installation of the cover.

Models 135 thru 200hp

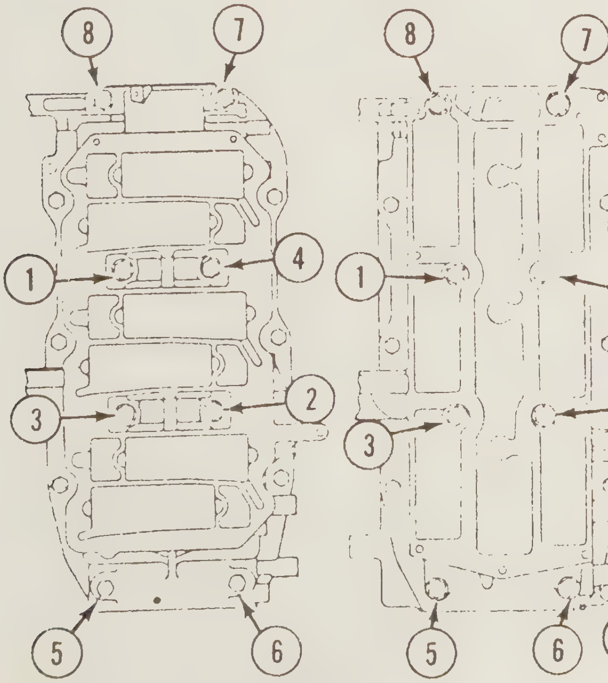
37- Place the cover in position on the crankcase. Coat the eight 3/8" center main crankcase bolts with light weight oil. Install the bolts through the cover and bring them up just **FINGERTIGHT**. Now, tighten the eight bolts progressively in three stages, as shown in the illustration, to a torque value of 38 ft lb (47.7Nm).





36

Install the remaining six 5/16" bolts and tighten them to a torque value of 180 in lb (22.6 Nm). After all the bolts securing the crankcase cover to the crankcase have been tightened to the required torque value, rotate the crankshaft through several revolutions and check for smoothness of operation. If the crankshaft binds, catches or has roughness, remove the crankcase cover and check the sealing rings for proper alignment.



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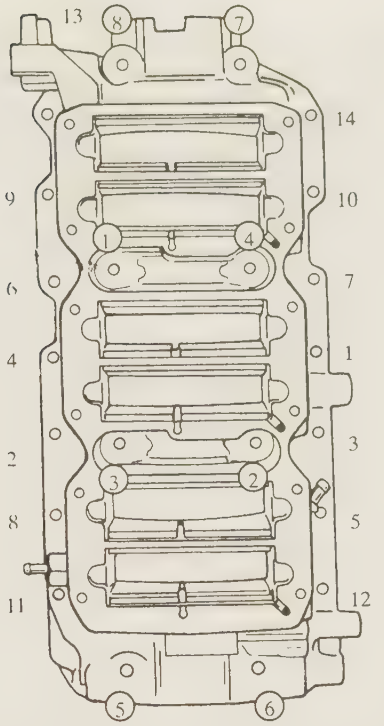


37 A

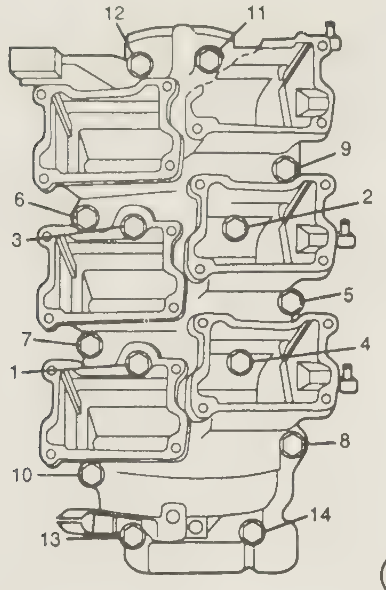
Install the remaining bolts for the upper and lower end cap flanges. Tighten the upper end cap bolts to a torque value of 150 in lb (16.9 Nm). Tighten the lower end cap bolts to a torque value of 80 in lb (6.8 Nm).

Crankcase Cover
Model 225hp

37A- Place the cover in position on the crankcase. Coat the eight M10 x 1.5 metric center main crankcase bolts with light weight oil. Install the bolts through the cover and bring them up just **FINGERTIGHT**. Now, tighten the eight bolts progressively in three stages, as shown in the illustration, until a torque value of 30 ft lb (40.7Nm) is reached. Tighten the bolts an additional 90° (1/4 turn), once again in the torque sequence.

Install the remaining fourteen M8 x 1.25 metric bolts through the cover and tighten them progressively in three stages, as shown in the illustration to a torque value of 28 ft lb (37.9 Nm). After all the bolts securing the crankcase cover to the crankcase have been tightened to the required torque value, rotate the crankshaft through several revolutions and check for smoothness of operation. If the crankshaft binds, catches or has roughness, remove the crankcase cover and check the sealing rings for proper alignment.

Install the remaining bolts for the lower end cap flanges. Tighten the lower end cap bolts to a torque value of 85 in lb (9.6 Nm).

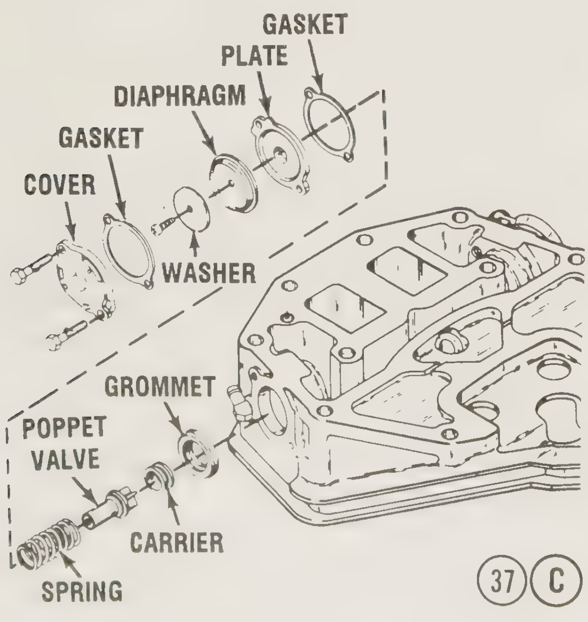


37 B

Crankcase Cover
Model 275hp

37B- Place the cover in position on the crankcase. Coat four of the center main crankcase bolts with light weight oil. Install the four bolts through the cover in positions 1 thru 4 **ONLY**. Now, tighten the four bolts progressively in three stages, as shown in the illustration to a torque value of 30 ft lb (40.7 Nm). Coat the ten remaining crankcase cover bolts with light weight oil. Install these ten bolts through the cover in positions 5 thru 14. Tighten these ten bolts progressively in three stages, as shown in the illustration, to a torque value of 30 ft lb (40.7 Nm). After all the bolts securing the crankcase cover to the crankcase have been tightened to the required torque value, rotate the crankshaft through several revolutions. Check for smoothness of operation. If the crankshaft binds, catches or has roughness, remove the crankcase cover and check the sealing rings for proper alignment.

Remove the two bolts in the lower end cap flange. Clean all four lower end cap bolt threads with Loctite Primer "T". Apply one or two drops of Loctite # 271 to the threads of all four bolts. Install the four bolts through the lower end cap flange and tighten the bolts to a torque value of 150 in lb (16.9Nm).



37 C

37C- Install the water pressure relief valve components into the exhaust plate, as shown in the illustration. Tighten the screw securing the poppet valve to a torque value of 40 in lb (4.5 Nm). Apply Loctite Grade "A" to the threads of the cover bolts. Install the cover bolts through the cover, gasket and relief valve assembly. Tighten the cover bolts securing the cover to the exhaust plate to a torque value of 150 in lb (16.9 Nm).

Slide the exhaust plate gasket and the exhaust plate over the threaded studs on the driveshaft end of the crankcase. Secure the exhaust plate to the crankcase with four nuts and lock washers. Tighten the nuts to a torque value of 30 ft lb (40.7Nm).

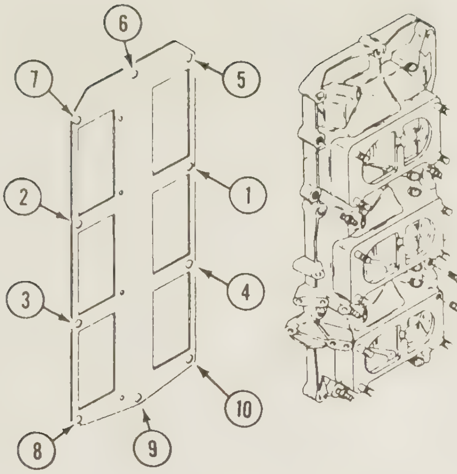
All Models

38- Install the reed block housing and gasket onto the powerhead and secure it in place with the attaching bolts. Tighten the bolts to the required torque value given the Specifications in the Appendix, in three progressive stages. Follow the sequence given in the accompanying illustration.

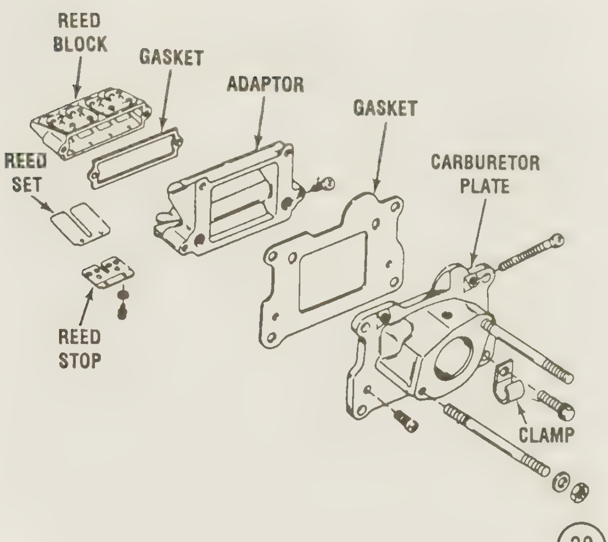
SPECIAL REED BLOCK WORDS

Four different reed block designs are used on the powerheads covered in this manual. Therefore, identify the design in the illustration. Tightening sequence is indicated on the gasket for clarity.

39- Route the bleed hoses through the bleed hose clamps. Connect the hoses from the reed block housing to the fittings on the side of the cylinders. One bleed hose extends from the reed block housing to each cylinder. The fittings on the side of the cylinder block are marked with a stamped letter.



MODEL 135HP THRU 200HP
VERTICAL REED MOUNT



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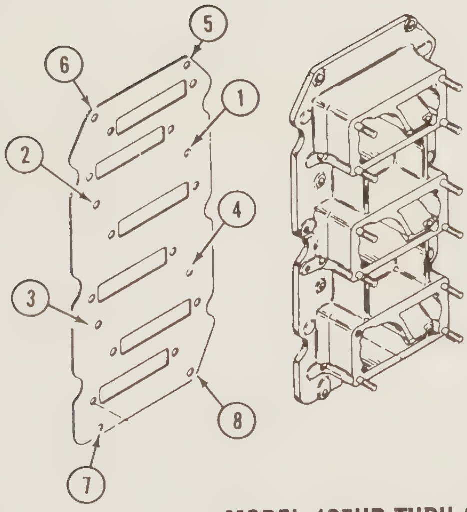
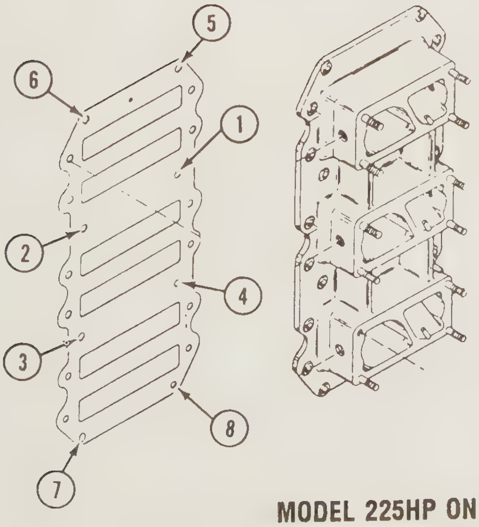


MODEL 135HP THRU 200HP
HORIZONTAL REED MOUNT

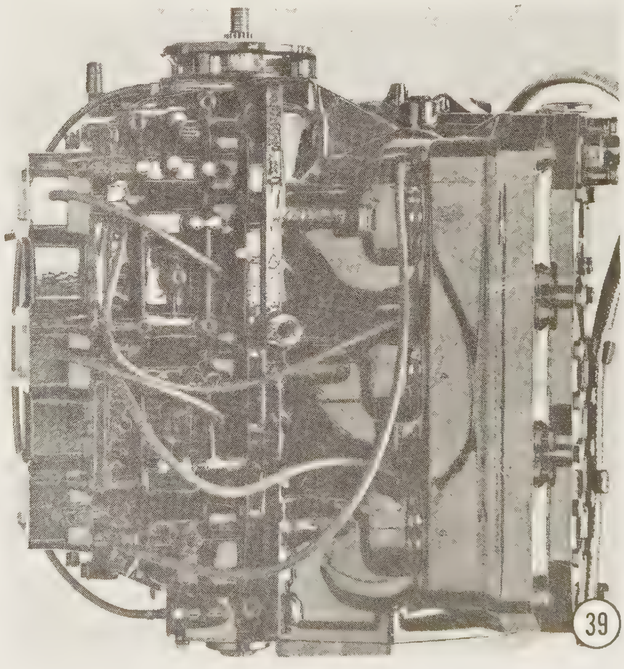


MODEL 225HP ONLY
HORIZONTAL REED MOUNT

CRITICAL WORDS

The bleed hoses are properly installed when the hose from check valve "**A**" is connected to the cylinder fitting marked "**A**"; "**B**" is connected to "**B**", etc. Detailed bleed hose routing illustrations are included in the Appendix.

Check a second time, to ensure the bleed hoses are connected properly. If the hoses are not connected correctly, the powerhead will not function **SATISFACTORILY.** Imagine powerhead performance if one high-tension spark plug lead became disconnected. Same is true for the bleed hoses -- improper routing -- poor performance. Therefore, study the routing illustrations in the Appendix **CAREFULLY**.



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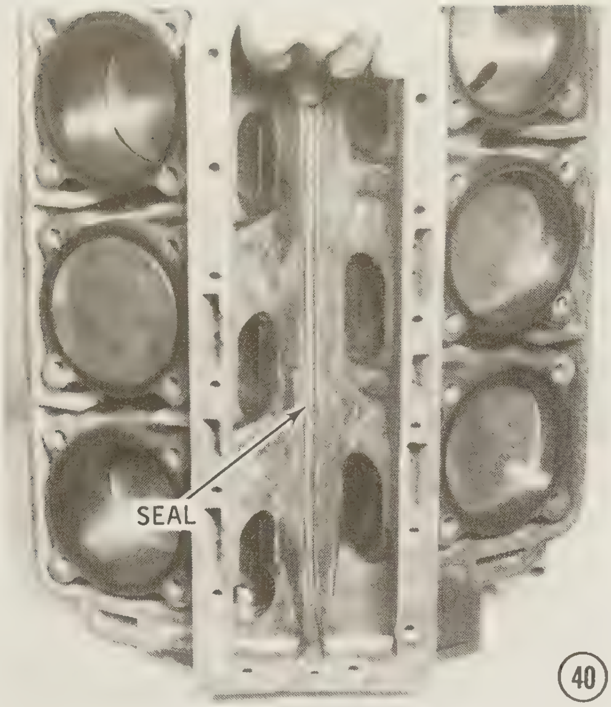


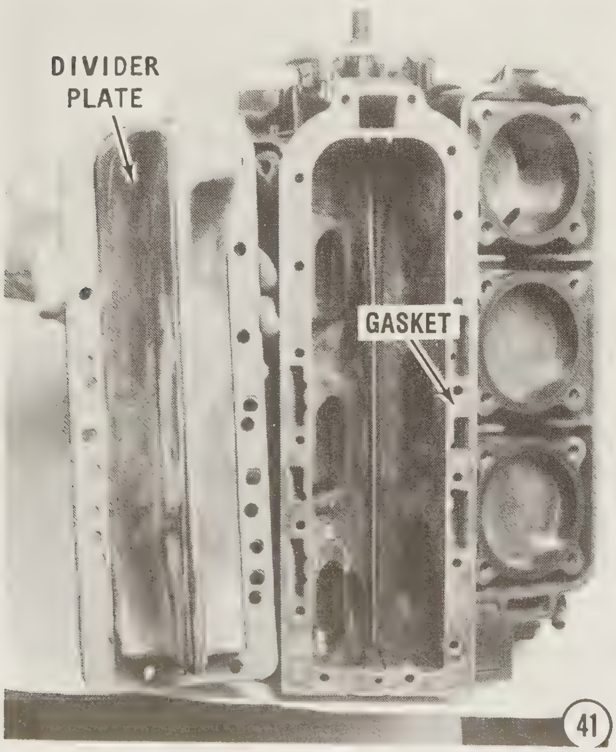
40

Models 135 thru 175hp with 122 or 142 Cubic Inch Powerheads

40- Place the exhaust divider plate seal into the cylinder block slot between the exhaust ports.

CRITICAL CAUTION

New gaskets **MUST** be used and must be properly installed to allow adequate water flow through the powerhead. If water flow is restricted or blocked by a gasket improperly



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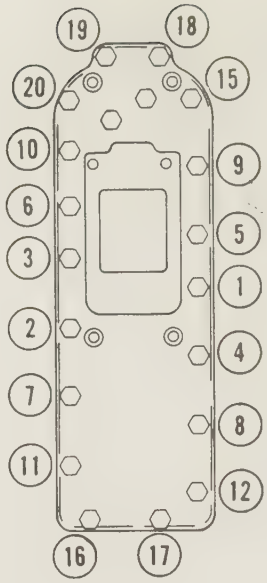
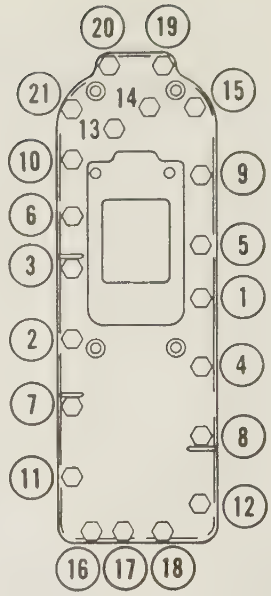


MODEL 135HP THRU 175HP (122 & 142 CU. IN.)

42



MODEL 150HP THRU 200HP (153 CU. IN.)

42 A

installed, the powerhead will be severely damaged in a matter of minutes after startup.

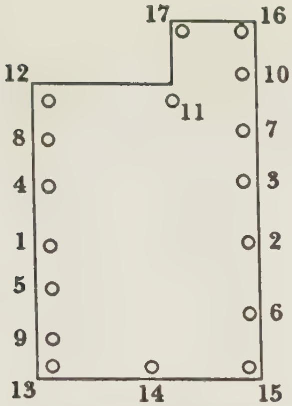
41- Position a **NEW** divider plate gasket on each side of the exhaust divider plate with the holes in the gasket aligned with the holes in the divider plate. Install the exhaust divider plate and gaskets onto the cylinder block.

42- Install the exhaust manifold cover over the divider plate gasket and secure it in place with the attaching bolts. Tighten the bolts to the required torque value given in the Specifications in the Appendix, and to the required torque value, in three progressive stages following the tightening pattern given in the accompanying illustration. One of the exhaust manifold cover bolts also secures a wiring harness support plate assembly. The location of this bolt was identified during disassembly in Step 21. Install the wiring harness support plate assembly under this bolt.

Models 150 thru 200hp with 153 Cubic Inch Powerheads

42A- Place the exhaust divider plate seal into the cylinder block slot between the exhaust ports.

Position a **NEW** gasket onto the exhaust divider plate with the holes in the gasket aligned with the holes in the divider plate. Install the exhaust divider plate and gasket onto the cylinder block. Clean and dry the threads of the exhaust divider plate bolts. Apply Loctite Grade "A" to the threads of the bolts and secure



TIGHTENING SEQUENCE
MODEL 275HP)

42 B

the exhaust divider plate to the cylinder block. Tighten the bolts to the required torque value given in the Specifications in the Appendix. Tighten the bolts in three progressive stages, following the pattern given in the accompanying illustration.

Models 225 and 275hp Powerhead

42B- Position a **NEW** gasket onto the exhaust cover plate with the holes in the gasket aligned with the holes in the exhaust cover plate. Install the exhaust cover plate and gasket onto the cylinder block. Clean and dry the threads of the exhaust cover plate bolts. Apply Loctite Grade "A" to the threads of the bolts and secure the exhaust cover plate to the cylinder block. Tighten the bolts to the required torque value given in the Specifications in the Appendix. Tighten the bolts in three progressive stages, following the pattern given in the accompanying illustration.

43

Models 135 thru 200hp

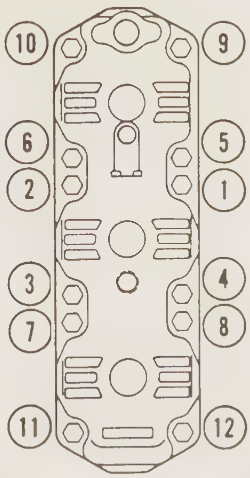
43- Wipe the cylinder head and the cylinder block head surface clean and dry of any oil. Position the cylinder head gasket onto the block with the numbered side of the gasket towards the outside of the block, as shown. **CHECK TO BE SURE** the head gasket is aligned with **ALL** bolt holes and dowel pins. Push the head gasket down over the dowel pins and flush against the block surface.

Position the cylinder head onto the block with the thermostat cavity towards the flywheel end of the powerhead. Coat the threads of the head bolts with light weight oil and install them into the head.

44- Tighten the bolts to the required torque value given in the Specifications in the Appendix. Tighten the bolts in three progressive stages, following the pattern given in the accompanying illustration. Repeat steps 43 and 44 for the other cylinder head.

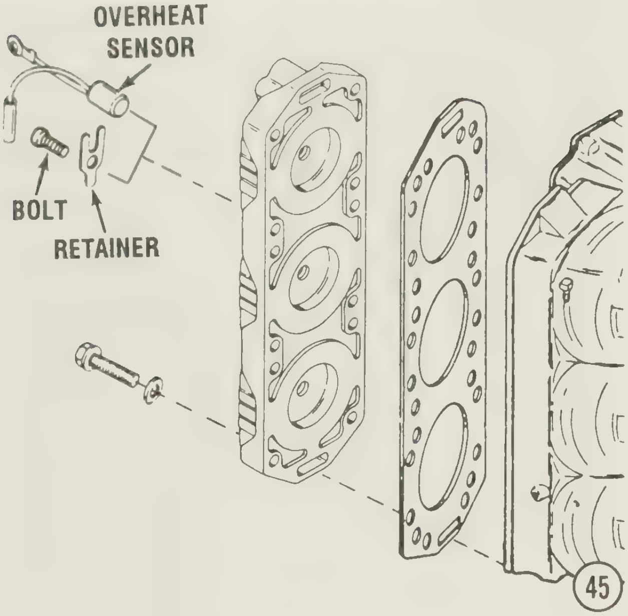
CRITICAL HEAD BOLT WORDS

When all work has been completed and the powerhead is ready for the break-in period, after the first half hour, but before the first full hour of running time, the head bolts **MUST** be loosened approximately 1/4 turn, and then retightened -- in sequence -- to the total torque value given in the Appendix. **DO NOT** loosen



TIGHTENING SEQUENCE
MODEL 135 THRU 200 HP

44



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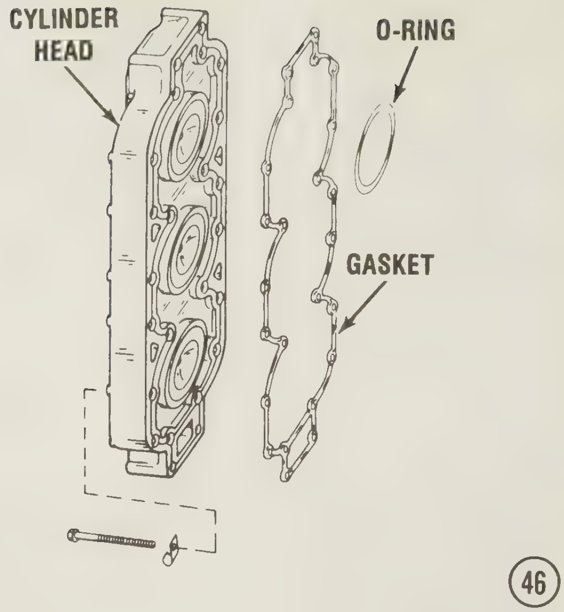


46

more than one bolt at a time while performing the re-tightening procedure. If possible, perform this final tightening while the powerhead is warm.

ASSEMBLING WORK CONTINUES

45- Install the overheat temperature sensor into the starboard cylinder head below the No. 1 spark plug opening. Secure the sensor to the cylinder head with the retainer and bolt. Tighten the retainer bolt to a torque value of 200 in lb (22.6Nm).

Models 225 and 275hp

FIRST, THESE GASKET AND SEAL WORDS

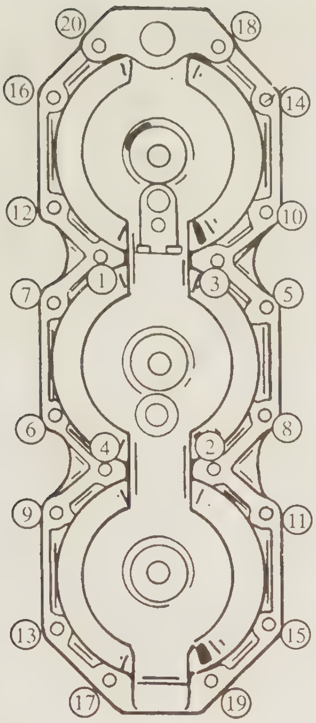
The cylinder heads for the Model 225 and 275hp powerheads do not use a conventional one piece head gasket between the block and the cylinder head. These powerheads use a long rubber seal which is pressed into a groove around the cylinder head. This seal provides a watertight seal between the cylinder head and block assembly. An **O**-ring is pressed into a groove around each combustion chamber in the cylinder head. These **O**-rings seal the combustion chamber. Use of Needle Bearing Assembly lubricant is recommended to aid in holding the seals and **O**-rings in place while assembling the cylinder head to the block assembly.

46- Wipe the cylinder head and the cylinder block head surface clean and dry of any oil. Check the grooves in the cylinder head for any old seal or **O**-ring material which may have been overlooked. Apply a light coating of needle bearing assembly lubricant to each of the cylinder **O**-rings. Install the **O**-rings into the groove in the cylinder head. Press firmly on the **O**-ring to ensure it will fit snug into the groove. Apply a light coating of needle bearing assembly lubricant to the rubber seal. Position the seal on the cylinder head with all the bends and curves aligned. Press the seal firmly down into the groove. Do not stretch the seal while it is being pressed into the groove. Such action would cause an excessive amount at the end of the seal.

CAREFULLY position the cylinder head onto the block using two head bolts as guides. Hold the cylinder head slightly away from the block to prevent disturbing the seals and **O**-rings. Have an assistant tighten the two head bolts evenly, while drawing the cylinder head down against the block. Coat the threads of the head bolts with light weight oil and install them into the head.

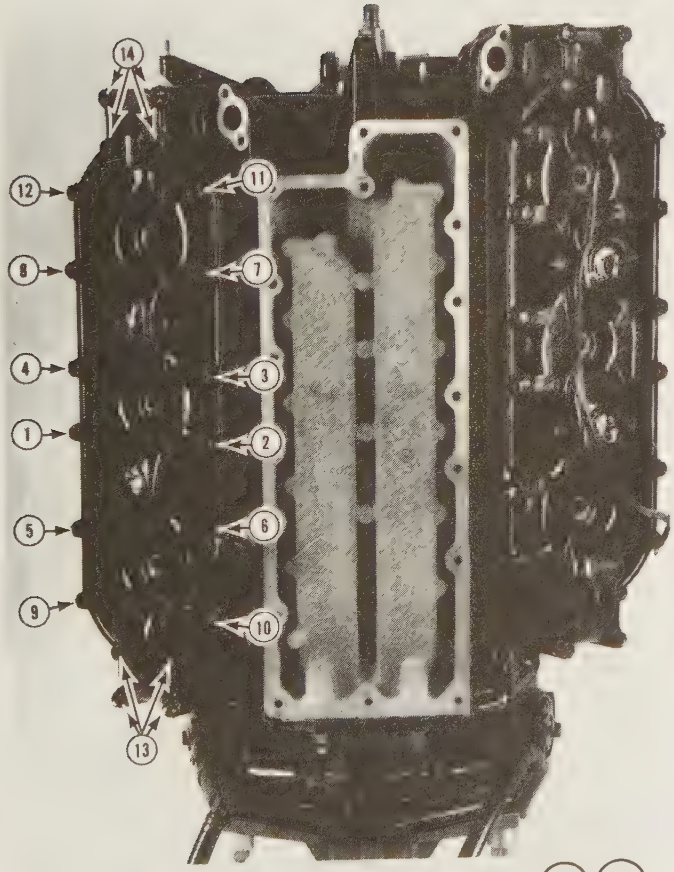
Model 225hp Cylinder Head Bolt Tightening Sequence

46A- Tighten the bolts in three progressive stages, following the pattern given in the accompanying illustration. Tighten the head bolts numbered 18 and 20 in the illustration to 30ft lb (40.7Nm). Tighten all remaining head bolts to 20 ft lb (27.1 Nm). After all bolts have been tightened to the required torque value, rotate each bolt in sequence an additional 90^0 or 1/4 turn. Repeat steps 46 and 46A for the other cylinder head.



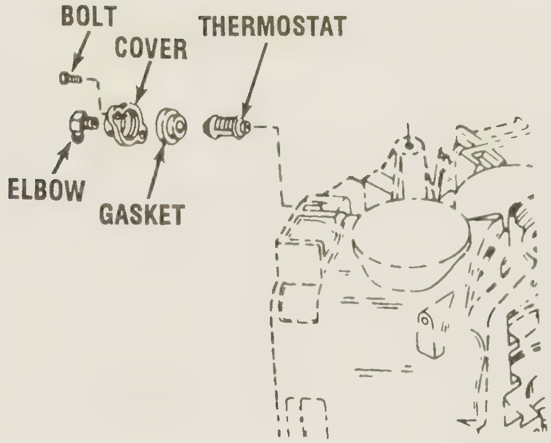
MODEL 225HP

46 A



MODEL 275HP

46 B



47

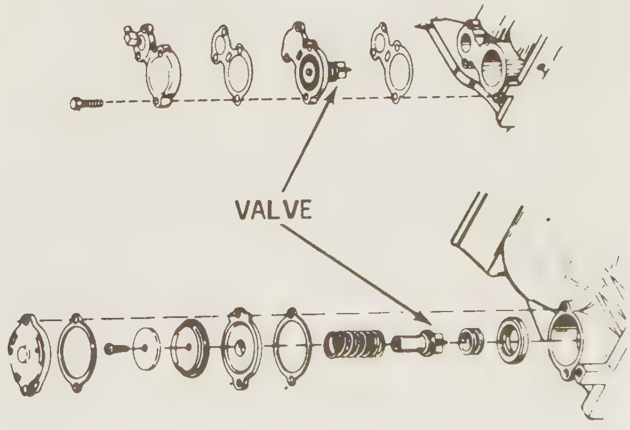
Model 275hp Cylinder Head
Bolt Tightening Sequence

46B- Tighten the bolts to the required torque value given in the Specifications in the Appendix. Tighten the bolts in three progressive stages, following the pattern given in the accompanying illustration. Repeat steps 46 and 46B for the other cylinder head.

All Models
Thermostat and Cover

47- Place a **NEW** thermostat gasket around each thermostat with the shoulder of the gasket **AGAINST** the cylinder head. Install the thermostat, thermostat covers with the water distribution elbow, and the hoses onto the flywheel end of the cylinder heads or block -- depending on the model being serviced.. Install and tighten the thermostat cover bolts to the required torque value given in the Specifications in the Appendix.

48- Connect the water distribution hoses from the starboard side thermostat cover to the discharge fitting on the pressure relief valve



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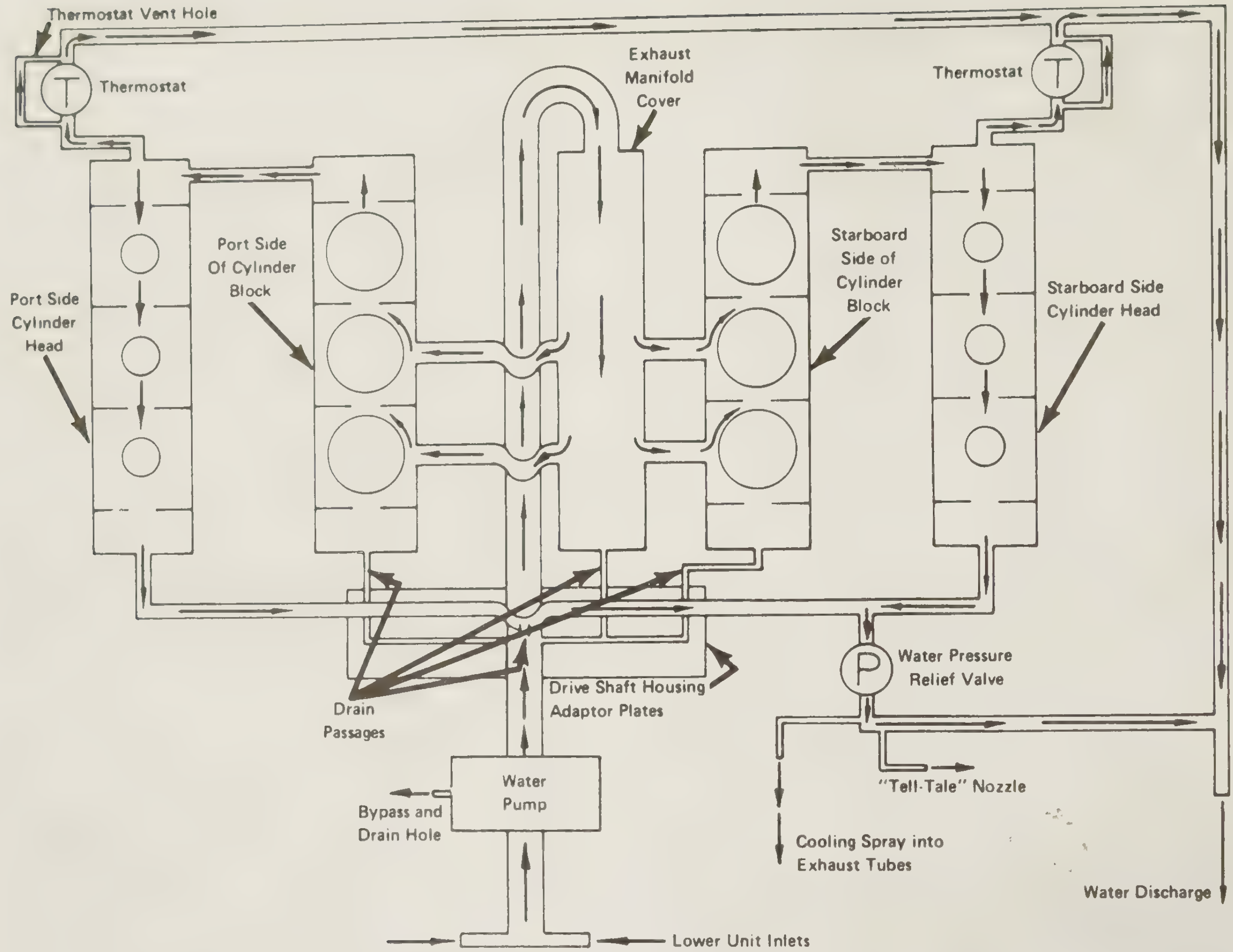
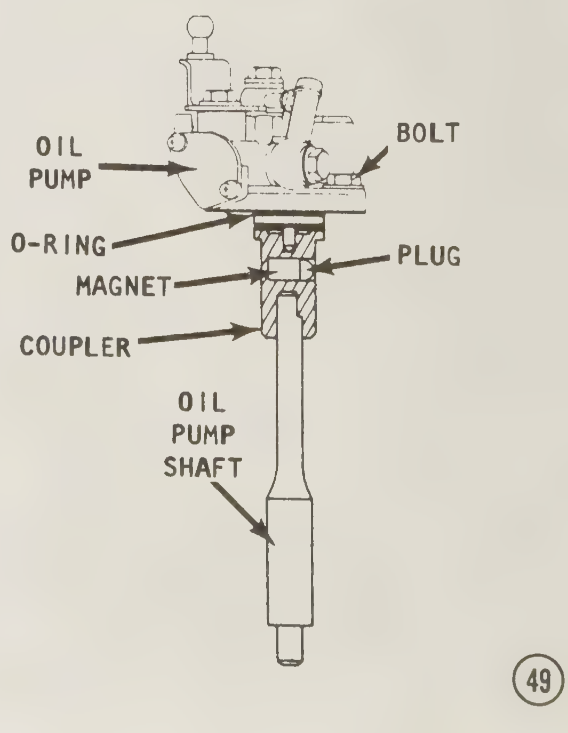


Functional diagram to illustrate typical water circulation through a V6 powerhead.

cover. Secure the hose to the fitting with a hose clamp. The accompanying illustration, on the this page, depicts a typical V6 cooling system water flow.

49- Insert the oil pump shaft into the block with a **COUNTERCLOCKWISE** rotation to ensure the splines on the shaft index with the teeth of the oil pump gear on the crankshaft. The top of the shaft has a flat edge to mate with the coupler. If the plug and magnet were removed from the coupler, a directional compass is required for assembly. Identify the **SOUTH** end of the magnet. Apply a thin coating of Multipurpose Lubricant to the magnet and the plug. The lubricant will hold them in place during installation of the coupler. Now, insert the magnet into the coupler with the **SOUTH** end of the magnet going in first. Insert the plug into the opening with the flat side of the plug going in **FIRST** to bear against the magnet.



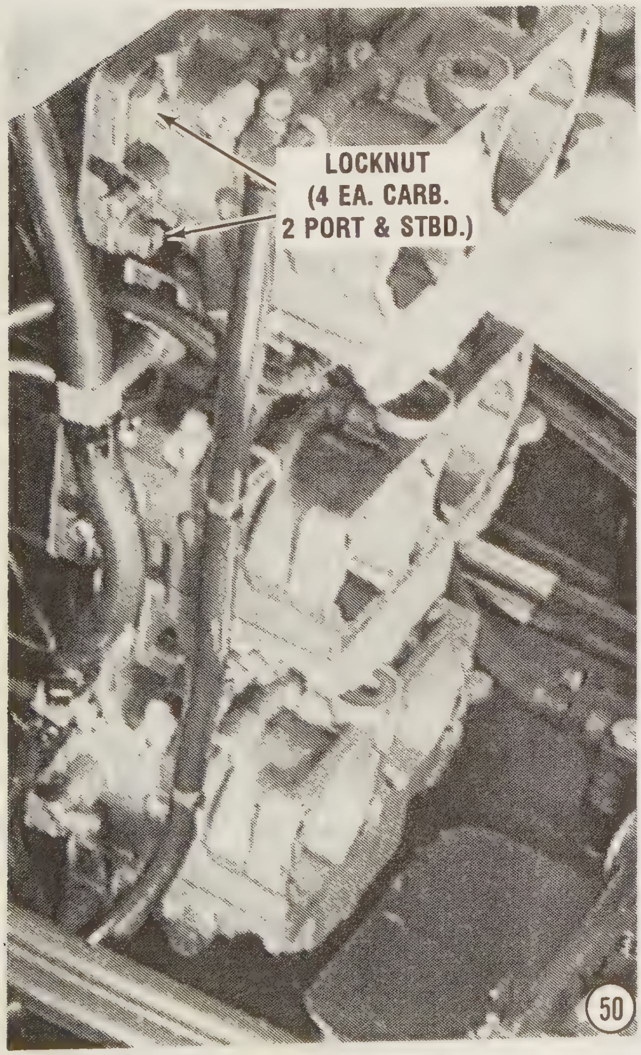
Lower the coupler onto the oil pump shaft. When the coupler has mated to the shaft correctly, it will not be possible to rotate the coupler. Place the **O**-ring over the coupler and index the shaft of the oil pump into the top recess of the coupler. Secure the oil pump to the block with the attaching hardware. Connect the outlet hose.

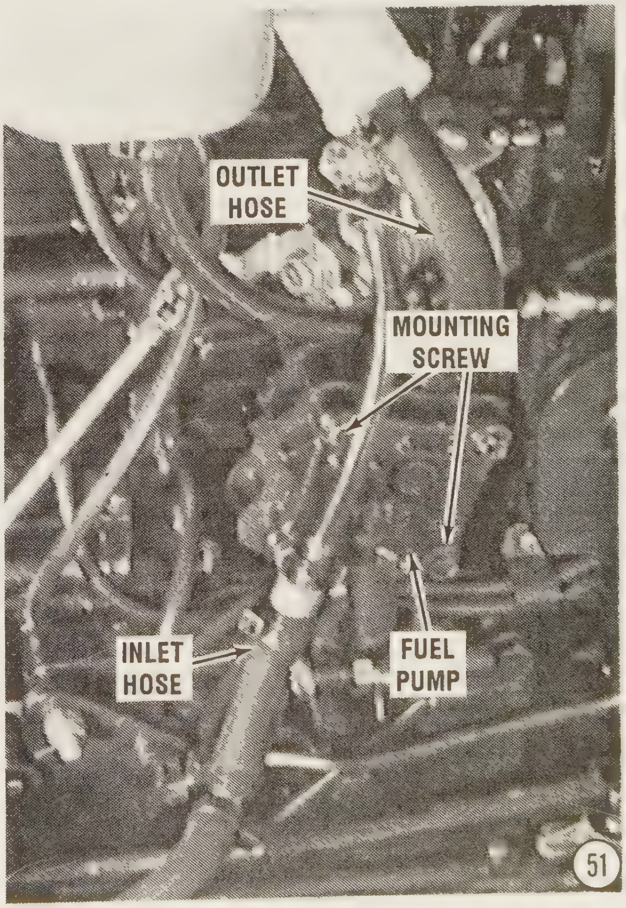
Powerhead Build-up
All Models

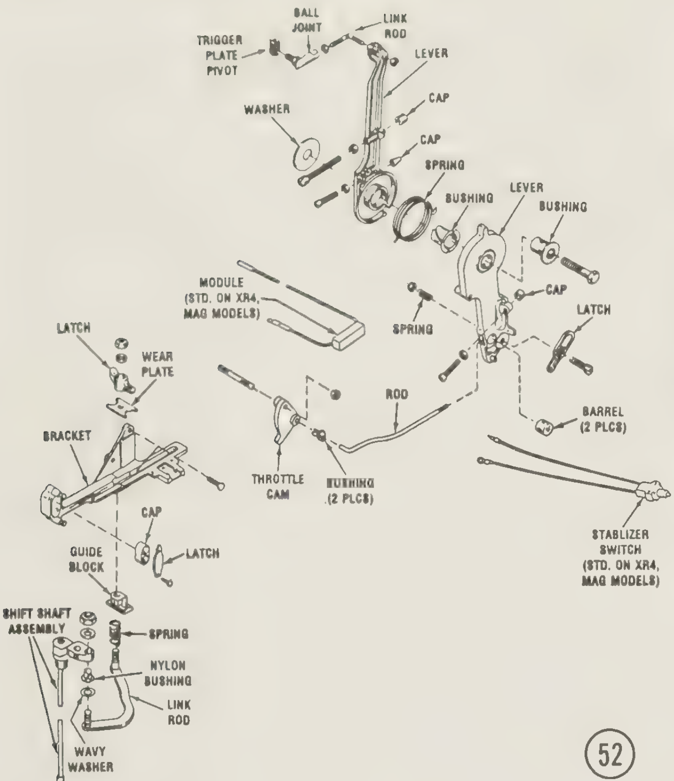
50- Position **NEW** carburetor gaskets onto the carburetor mounting flanges of the reed block housing. Install the carburetors, enrichener plate/air box, and cowling brackets onto the powerhead as an assembly. Secure the carburetors with the 12 locknuts -- four on each carburetor. Tighten the nuts to the torque value given in the Specifications in the Appendix. Connect the bleed hose from the reed block housing fitting to the check valve located at the lower port side corner of the air intake box.

51- Install the fuel pump gaskets and diaphragm. Assemble the fuel pump to the reed block housing. Secure the fuel pump assembly in place with the two screws tightened to the torque value given in the Specifications in the Appendix.

52- Install the control cable anchor bracket to the crankcase cover with the three attaching bolts. Apply a coating of Multipurpose Lubricant to the bushing in the vertical throttle lever. Install a flat washer around the pivot bolt. Attach the vertical throttle lever assembly to the cylinder block with the pivot bolt. The flat washer **MUST** be installed between the throttle lever and the cylinder block. Tighten the pivot bolt securely. Lubricate the two throttle cam bushings with Multipurpose Lubricant. Install the throttle cam, with one bushing on each side of the cam, onto the reed block housing stud. Secure the throttle cam with the locknut. Thread the locknut onto the stud until two or three stud threads can be seen on the outside of







52

the locknut. **DO NOT** tighten the locknut, because the cam must be **FREE** to swivel.

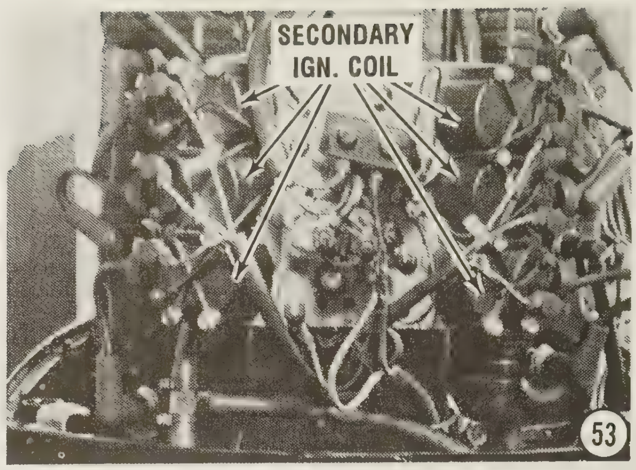
53- Attach the ignition plate, with the electrical components, to the starboard side of the powerhead with the three bolts and flat washers. Check to be sure the ground wires and "J" clips are properly installed, and then tighten the bolts securely. Apply a drop of Loctite Type "A" onto the threads of the secondary ignition coil attaching screws.

Install the six secondary ignition coils and the coil covers onto the exhaust manifold cover. Connect the ground wires, the negative terminals of the coils around the appropriate screws, and then secure the coils and coil covers with the screws.

Connect the Green, Green/White, and Green/Red switch box wires to the positive terminals of the respective secondary ignition coils. Secure the connection with a lockwasher, and nut. Cover the coil terminals with the rubber boots.

CRITICAL WIRE LEAD WORDS

The Green, Green/White and Green/Red switch box wire leads have numbered tape flags attached. The switch box wire lead identified with the "1" on it **MUST** be attached to the ignition coil to fire the No. 1 cylinder. The same is true for the other wire leads, coils and cylinders.



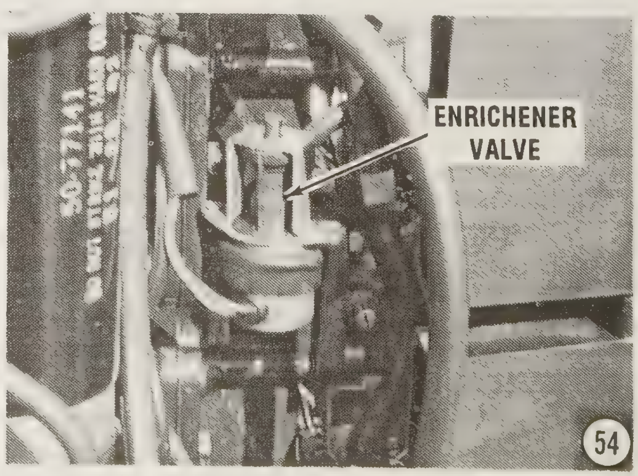
53

Connect the White/Green powerhead harness wire to the terminal block with the temperature sender wires attached. Connect the wire -- not grounded -- to the terminal. Insulate the terminals with Liquid Neoprene®.

54- Attach the enrichener valve to the starboard side of the intake manifold and secure with the screws and nuts. Connect the wire leads to the terminal block and the fuel hose to the valve. Connect the idle stabilizer or ignition modules to the switch box. Refer to the individual wiring diagrams in the Appendix.

Connect the Yellow/Black powerhead harness wire to the enrichener valve terminal block.

Secure the connection with a lockwasher and nut. Insulate the terminal with Liquid Neoprene. Place the cranking motor, with rubber collars, in position on the crankcase cover. Secure the motor in place with the upper and lower covers. Check to be sure the ground wire is installed on the lower mounting bolt, and then tighten the bolt to the torque value given in the Specifications in the Appendix. Connect the electrical cables to the cranking motor. Insulate the cable ends with Liquid Neoprene.



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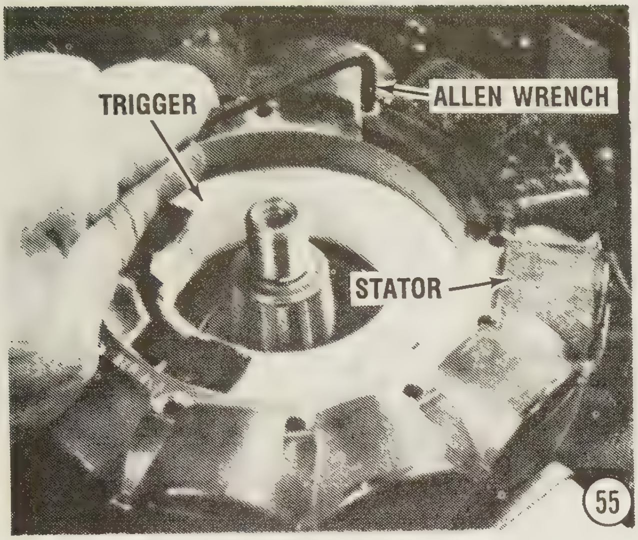
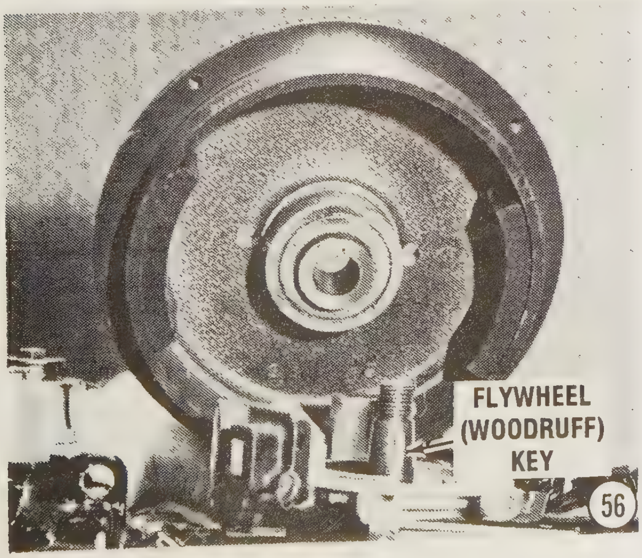


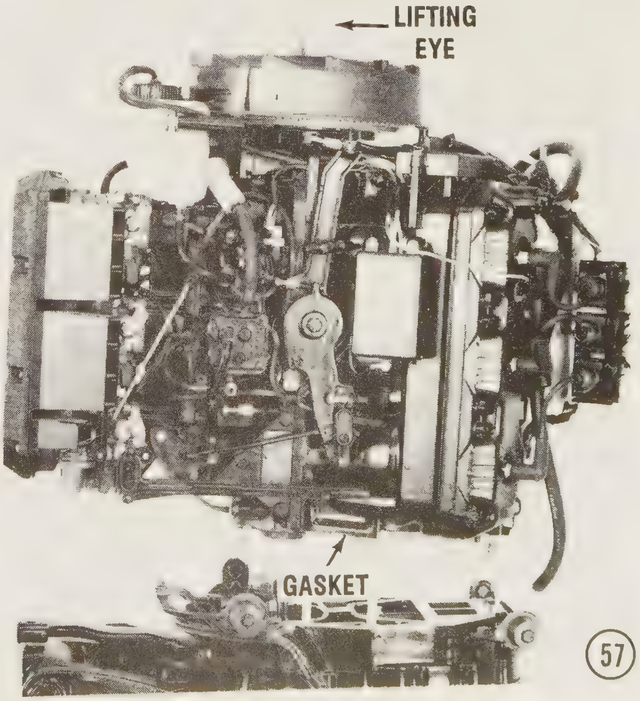
55- Install the trigger plate assembly in the upper end cap and insert the link rod swivel into the vertical throttle lever. Secure the link rod to the throttle lever with a locknut tightened securely. Apply a drop of Loctite Type "A" onto the threads of the stator attaching screws. Install the stator assembly in position in the upper end cap and secure it in place with the attaching screws. Tighten to the torque value given in the Appendix.

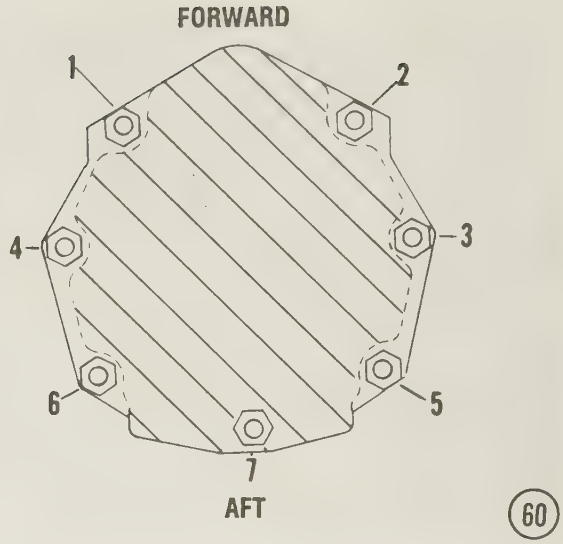
Connect the stator wires and trigger wires to the proper terminals of the switch boxes. Wires with a yellow identification sleeve around them **MUST** be connected to the outer switch box. The outer switch box fires cylinders No. 2, 4 and 6. Install the necessary sta-straps to secure the wiring. Install the wiring into the proper "J" clips, and then close the clips.

56- Insert the flywheel key in the crankshaft keyway. Check the inside rim of the flywheel to be sure metal particles are not stuck to the flywheel magnets. Check to be sure the inside taper of the flywheel and the taper on the crankshaft are clean of dirt or oil, to prevent the flywheel from "walking" on the crankshaft during operation. Slide the flywheel down the crankshaft with the keyway in the flywheel aligned with the key on the crankshaft. Rotate the flywheel **CLOCKWISE** and check to be sure the flywheel does not contact any component or any of the wiring. Slide a flat washer onto the crankshaft, and then thread the flywheel nut onto the crankshaft. Hold the flywheel with a flywheel strap and tighten the nut to the torque value given in the Specifications in the Appendix. Install the flywheel cover and secure it in place with the flat washers and wingnuts.



57- Thread a lifting eye into the flywheel as far as it will go. For **SAFETY**, check to be sure the lifting eye is properly installed. Using a suitable hoist, lift the powerhead. Place a **NEW** gasket around the powerhead studs and into position on the base of the powerhead. Lubricate the driveshaft splines with Multipurpose Lubricant. Slowly lower the powerhead down onto the driveshaft housing. It may be necessary to rotate the flywheel slightly to align the crankshaft splines with the driveshaft splines. Once the splines index, lower the powerhead fully into place on the driveshaft housing.



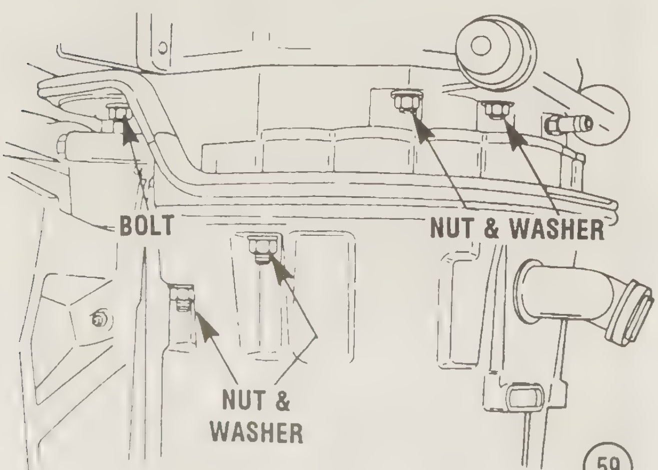


Model 135 thru 225hp
1990 thru 1991 and
Early 1992

58- Secure the powerhead to the driveshaft housing with the 10 flat washers and 10 locknuts. Tighten the locknuts in three stages to the torque value given in the Specifications in the Appendix. Disconnect the hoist from the lifting eye, and then remove the eye from the flywheel. Install the plastic cap into the center of the flywheel.

Model 135 thru 225hp
1992 and On

59- Secure the powerhead to the driveshaft housing with the eight washers and locknuts -- four on each side -- port and starboard -- and the two bolts -- one on each side -- port and starboard and indicated in the accompanying illustration. Tighten the locknuts and bolts in three stages to the torque value given in the Specifications in the Appendix. Disconnect the hoist from the lifting eye, and then remove the eye from the flywheel. Install the plastic cap into the center of the flywheel.



Model 275hp Only

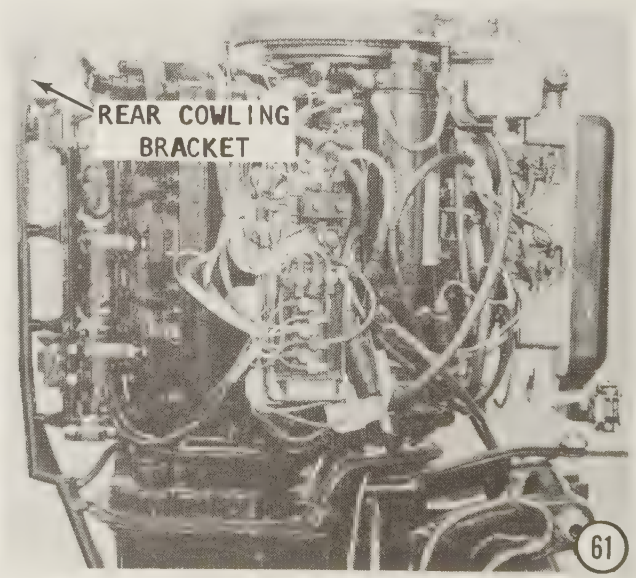
60- Secure the powerhead to the driveshaft housing with the six lockwasher and locknuts plus the one hex bolt in the center aft. Tighten the locknuts and bolt to the torque value listed in the Appendix in the **EXACT** pattern shown in the accompanying illustration.

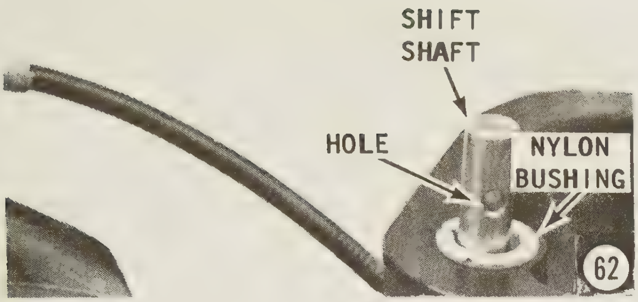
Still Model 275hp Only

61- Install and secure the rear cowling bracket assembly to the exhaust manifold cover with the three flat washers and three locknuts.

All Units

Connect the water hose from the port side of the exhaust adaptor plate to the tattle tale nozzle. Secure the hose to the nozzle with a hose clamp. Install the spring and guide block





onto the shift link rod with the anchor pin **FORWARD**, and then insert the shift link rod into the control cable anchor bracket. Secure the shift link rod assembly with the wear plate, latch, washer and locknut. Thread the locknut onto the shift link rod until 2 or 3 threads are exposed beyond the top of the nut. **DO NOT** tighten the locknut.

Model 275hp Only

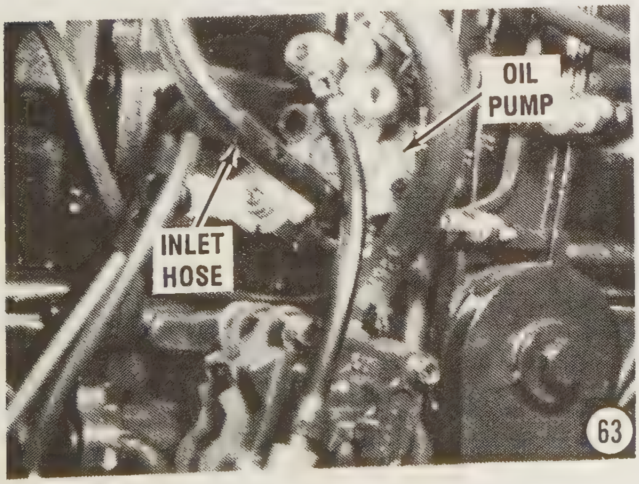
62- Install the nylon bushing over the shift shaft. With the lower unit in **NEUTRAL** gear, position the hole in the shift shaft parallel to the front surface of the powerhead. Place the shift arm over the shift shaft and secure it in place with a rolled pin.

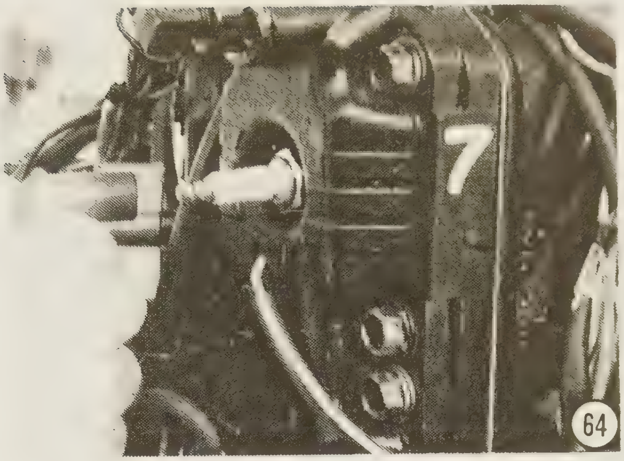
All Units

63- Install the oil reservoir and connect the outlet hose to the inlet side of the oil pump. To bleed the oil injection system, see Chapter 4.

64- Connect the ignition coil high tension leads to their respective spark plugs. Connect the remote control cables to the powerhead. Connect the powerhead battery cables to the battery terminals. Check to be sure the system polarity is maintained.

65- Plug the powerhead harness into the extension harness and secure the connection with the clamps.





Connect the powerhead and fuel tank lines.

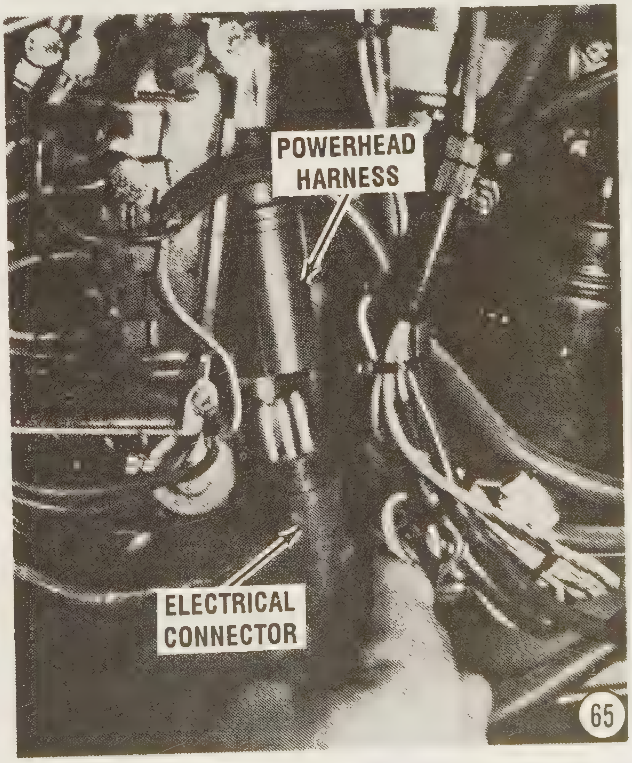
For complete detailed timing and synchronizing procedures, see Chapter 6.

Back the boat into a test tank or secure it in a body of water. Turn the fuel shutoff valve to the **ON** position.

Start the powerhead and follow the break-in procedures listed after the following caution.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump.



Break In Procedures

As soon as the powerhead starts, **CHECK** to be sure the water pump is operating. If the water pump is operating, a water mist will be discharged from the exhaust small hose at the rear of the driveshaft housing.

Check the cylinder block, both cylinder heads, both cylinder head covers, the exhaust manifold cover, and the thermostat covers for water leaks. If a powerhead lead/s is detected, the problem area **MUST** be corrected before placing the unit in service.

After three hours of powerhead operation, tighten the head bolts again to the torque value listed in the Appendix.

During the first 10 hours of operation, **DO NOT** operate the powerhead at full throttle (except for **VERY** short periods). Perform the break in as follows:

a- Operate at 1/2 throttle -- approximately 2500 to 3500 rpm -- for 30 minutes to one hour. Shut down the powerhead and re-tighten the cylinder head bolts in the **EXACT** sequence as described in the assembly procedures. Re-start the powerhead and run for one additional hour within the rpm limits as listed above.

b- Operate at any speed after two hours **BUT NOT** at sustained full throttle until another eight hours of operation.

c- Mix gasoline and oil during the break-in period -- total of ten hours -- at a ratio of 50:1 for **ALL** units -- including powerheads with oil injection.

d- While powerhead is operating during the initial period, check the fuel, exhaust, and water systems for leaks.

e- Refer to Chapter 6 for synchronizing the fuel and ignition systems.

After the test period, disconnect the fuel line. Remove the outboard unit from the test tank. Install the powerhead cowling and consider the powerhead rebuild job completed.

9
LOWER UNIT

9-1 DESCRIPTION

The lower unit is considered as that part of the outboard below the exhaust housing. The unit contains the propeller shaft, the driven and pinion gears, the drive shaft from the powerhead and the water pump. The shifting capabilites, including the forward and reverse gears together with the clutch, shift assembly, and related linkage, are all housed within the lower unit.

The lower unit may be removed and serviced without disturbing the remainder of the outboard unit.

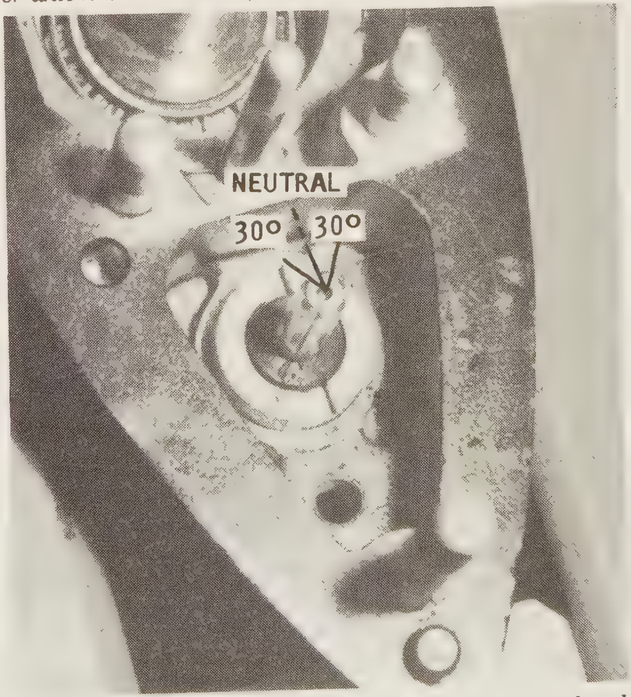
CHAPTER COVERAGE

The powerheads covered in this manual are mated with two similar lower units. The minor differences are limited to the shifting mechanism and the water pump design. These lower units are divided into two categories: The Cam-Shift and the E-Z Shift systems. Differences in procedures are clearly identified with a heading indicating the unit affected.

The E-Z Shift system is installed on powerheads Model 135hp thru 200hp including Magnum and XRi series. The E-Z shift utilizes a shift cam rotating inside the cam follower for shifting into and out of forward or reverse gear. This shift arrangement requires the shifting shaft to be removed **PRIOR** to "pulling" the propeller shaft from the lower unit housing.

The Cam Shift-II system is installed on lower units matched with the 150XR4, Magnum II and 150XR6, Magnum III powerheads since about 1989. The Cam Shift system utilizes a shift cam riding against a plunger for shifting

With the lower unit still attached to the powerhead, and with the unit in ***REVERSE*** *gear, rotate the propeller shaft* ***COUNTERCLOCKWISE.*** *If the shaft does not ratchet, the unit has a Cam-Shift. If the propeller shaft "rachets" when turned counterclockwise, the lower unit has the E-Z Shift.*



With the lower unit separated from the powerhead, and with the unit in ***NEUTRAL*** *gear, rotate the shift shaft clockwise and counterclockwise. If the shift shaft will rotate a full 360°, the unit has the Cam-Shift. If the shift shaft will only rotate about 30° in either direction, the unit has the E-Z Shift.*

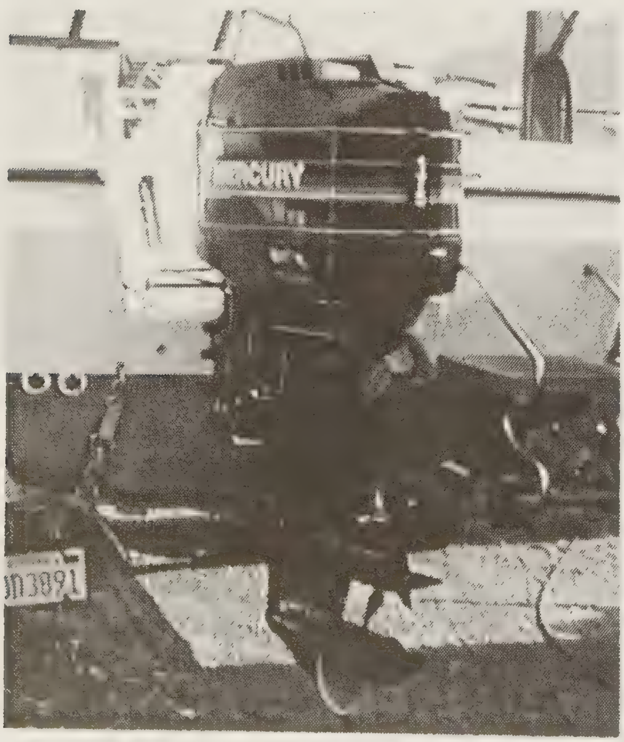
into and out of gear. The carrier bearing and propeller shaft may be "pulled" from the lower unit without removing the shift shaft.

An almost identical lower unit containing the same components as the Cam Shift system, with minor differences in the shift mechanism, is installed on outboard units with a Model 225hp powerhead. This second version of the Cam Shift system has very few minor differences. These differences are clearly identified in the procedures as the work progresses.

Test for "E-Z Shift" or "Cam-Shift-II" Lower Unit

A quick test should be made while the lower unit is still attached to the powerhead to determine which shift system is to be serviced -- the Cam-Shift or the E-Z Shift. This test should be performed before beginning **ANY** service work.

To quickly and accurately identify the shift system installed in the lower unit to be serviced, simply shift the lower unit into **REVERSE** gear, and then rotate the propeller shaft **COUNTERCLOCKWISE** by hand. If the shaft "rachets" when rotated, the lower unit has the E-Z shift system. If the shaft does not "ratchet", the lower unit has the Cam-Shift.



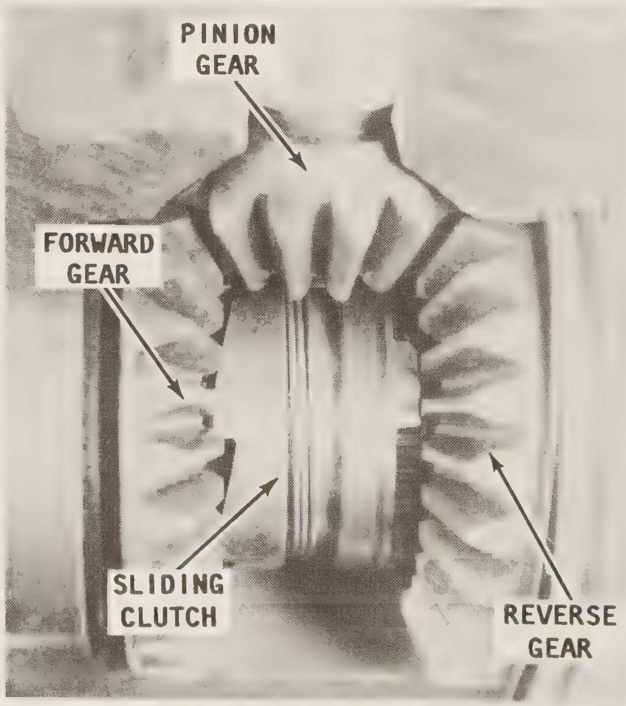
The Model 175hp unit is equipped with the E-Z shift system covered in detail in this chapter.

Counter Rotation Lower Units

Because of the increasing popularity and size of most outboards, especially the large horsepower units, a common practice has evolved -- using dual outboards. These dual units are usually installed on larger vessels -- sports fishing, charter and some commercial fishing boats.

In early years, a torque load problem existed with dual outboard installations. The propellers drastically rocked the vessel to one side as the powerheads were accelerated. To off-set this torque load from the propellers, the manufacturer developed a left handed drive or counter rotating lower unit. Therefore, when dual powerheads are accelerated, the torque from the right hand rotation propeller is off-set by the torque of the left hand or counter rotating propeller. This improvement has now made dual outboard installations a very popular choice when selecting propulsion for a larger boat.

The major difference between the standard right hand drive and the left hand counter rotating unit is in the gear arrangement within the lower unit. The forward and reverse gear locations are exchanged -- along with the thrust bearings and shims. With the gears in the new locations, the direction of propeller rotation is reversed -- opposite to the right hand drive lower unit.



*Cutaway view of the lower unit in **NEUTRAL**. The sliding clutch engages either the forward or reverse gear with the pinion gear on the end of the driveshaft.*

In the few cases when procedures for the left hand counter rotating unit differ from the right hand lower unit, special instructions have been provided and are clearly identified. The driveshaft, water pump and remainder of the lower unit is identical to the right hand rotation unit. Therefore, the procedures and illustrations are valid for both units.

PROCEDURES

Detailed instructions are presented for:

Troubleshooting -- Section 9-2, Page 9-4.
Lower Unit Removal - all units -- Section 9-3, Page 9-5.
Water Pump Removal - all units -- Section 9-4, Page 9-8.
Servicing Cam-Shift Units, including disassembling, exploded drawings, assembling, and adjustments -- Section 9-5, Page 9-11
Servicing E-Z Shift Units, including disassembling, exploded drawings, assembling, and adjustments -- 9-34
Water Pump Installation - all units -- Section 9-7, Page 9-64.
Cleaning and Inspecting - all units -- Section 9-8, Page 9-67.
Lower Unit Installation to Intermediate Housing- all units -- Section 9-9, Page 9-70.

Because so many procedures are common to the different lower units, except in specified areas, all service tasks for the particular unit being serviced are presented in one section. Therefore, the work moves along smoothly and when differences are encountered the steps to be followed are clearly indicated. By the same token, when the steps involve all units covered in the section, this fact is also boldly brought to the reader's attention.

ILLUSTRATIONS

Because this chapter covers such a wide range of models over an extended period of time, the illustrations included with the procedural steps are those of the most popular lower units. In some cases, the unit being serviced may not appear to be absolutely identical with the unit illustrated. However, the step-by-step work sequence will be valid in all cases. If there is a special procedure for a unique lower unit, the differences will be clearly indicated in the step.

SPECIAL WORDS BEFORE BEGINNING WORK

All threaded parts are **RIGHT-HAND** unless otherwise indicated.

If any water in the lower unit or metal particles are discovered in the gear lubricant, the lower unit should be completely disassembled, cleaned, and inspected.

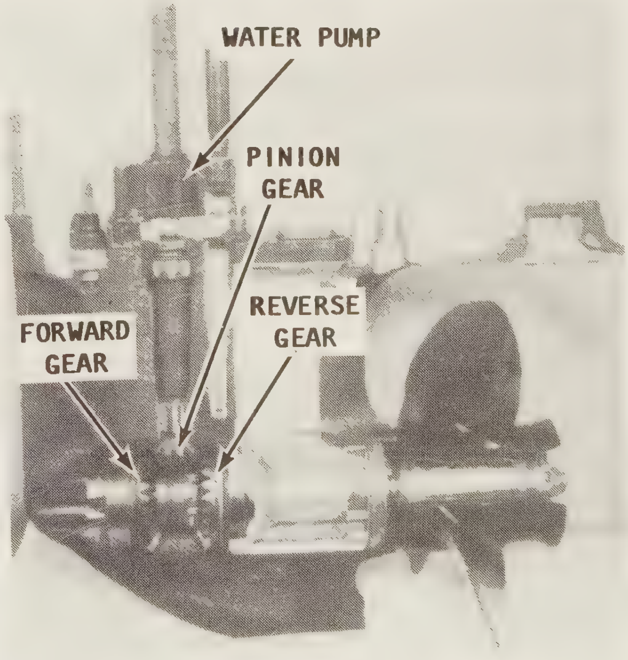
Use "soft jaws" in a vise to prevent damage to expensive parts.

Take time to obtain a suitable mandrel which will contact only the bearing race, when it is necessary to press or drive bearings into place.

Keep a record of shim material removed, as an aid during installation.

Maintain patience when adjusting gear depth and backlash to prevent noisy operation and possible premature gear failure. Adjustments **CANNOT** be rushed.

Oil seals and **O**-rings should always be replaced regardless of their appearance. Use Water Resistant Multipurpose lubricant on the seals and **O**-rings as an aid to installation.



Classroom type cutaway view of a lower unit with major parts, including the propeller and water pump, installed. Notice how the forward, reverse and pinion gears all are "bevel cut".

9-2 TROUBLESHOOTING

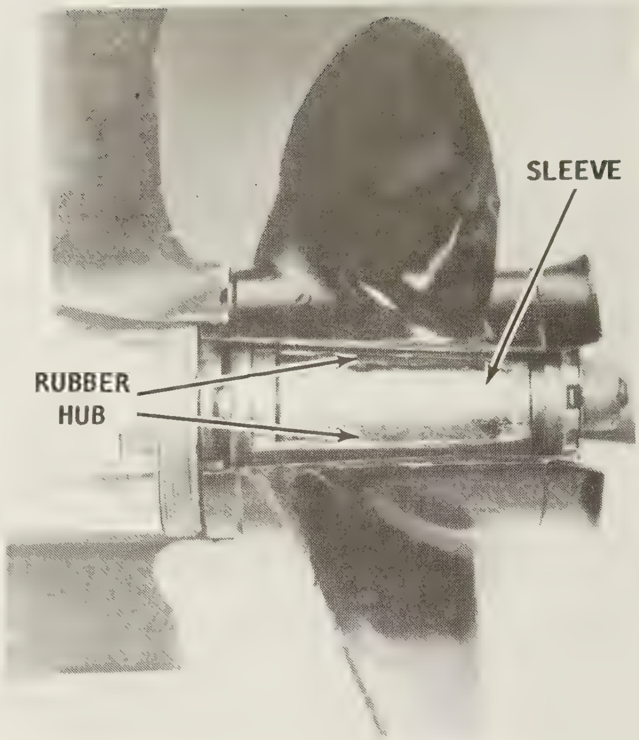
Troubleshooting **MUST** be done **BEFORE** the unit is removed from the powerhead to permit isolating the problem to one area. Always attempt to proceed with troubleshooting in an orderly manner. The "shot in the dark" approach will only result in wasted time, incorrect diagnosis, replacment of unneccessary parts, and frustration.

The following procedures are presented in a logical sequence with the most prevalent, easiest, and less costly items to be checked listed first.

1- Check the propeller and the rubber hub. See if the hub is shredded. If the propeller has been subjected to many strikes against underwater objects, it could slip on its hub. If the hub appears to be damaged, replace it with a **NEW** hub. Replacement of the hub **MUST** be done by a propeller rebuilding shop equipped with the proper tools and experience for such work.

2- Shift mechanism check: Verify the ignition switch is **OFF,** to prevent possible personal injury, should the powerhead start. Shift the unit into **REVERSE** gear and at the same time have an assistant turn the propeller shaft to ensure the clutch is fully engaged. If the shift handle is hard to move, the trouble may be in the lower unit, remote control cable, or the remote shift box.

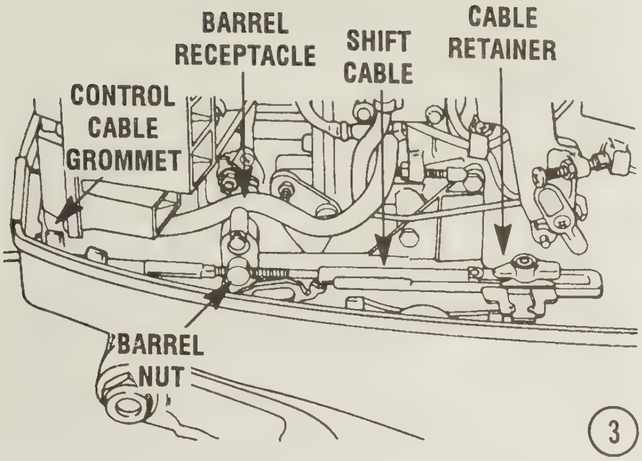
3- Isolate the problem: Disconnect the remote control shift cable from the powerhead by first loosening the cable retainer, and then



*Cutaway view showing the rubber hub and sleeve. The rubber hub protects the lower unit if the propeller should strike an underwater object. If the rubber hub loses its holding power with the inner hub of the propeller, the propeller hub **MUST** be replaced.*

sliding the barrel nut out of the barrel retainer. Lift the end of the shift cable off the guide pin.

Operate the remote shift lever from forward to reverse. If shifting is still hard, the problem is in the shift cable or the remote shift box, see Chapter 11. If the shifting feels normal with the remote-control cable disconnected, the problem must be in the lower unit.



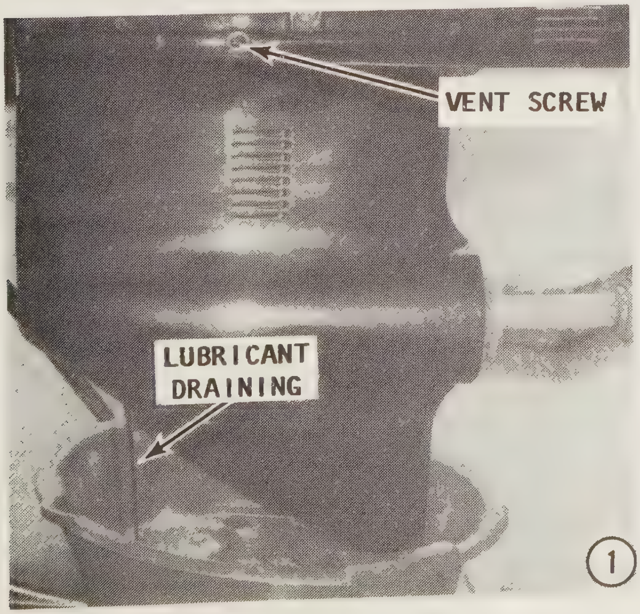
3

To verify the problem is in the lower unit, have an assistant turn the propeller and at the same time move the shift lever on the powerhead back-and-forth. If the shift lever is difficult to move or will not engage into forward or reverse gear, the problem is in the lower unit shift mechanism, and the lower unit **MUST** be disassembled to correct the problem.

9-3 LOWER UNIT REMOVAL ALL UNITS

ADVICE

Before beginning work on the lower unit, take time to **READ** and **UNDERSTAND** the information presented in Section 9-1. Verifying which lower unit is to be serviced will ensure the proper procedures are being followed after the lower unit is separated from the driveshaft housing and the water pump has been removed.



1

Disconnect the high tension spark plug leads, remove the spark plugs, and disconnect the leads at the battery terminals, before working on the lower unit.

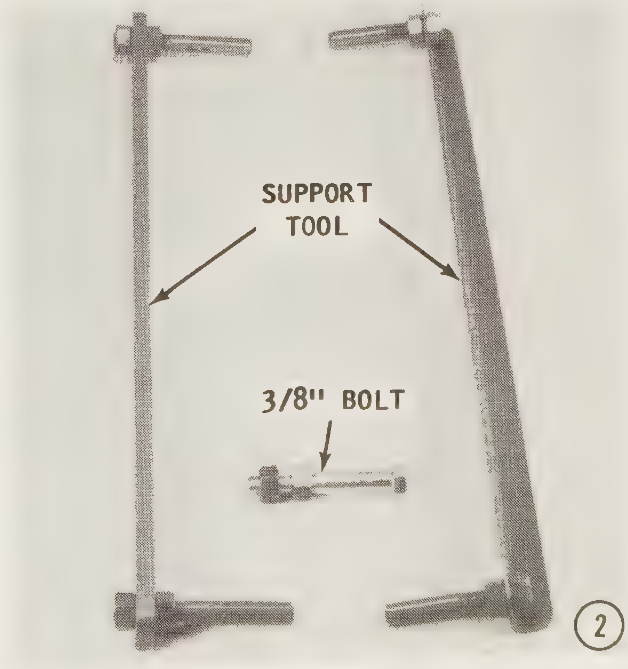
1- Position a suitable container under the lower unit, and then remove the **FILL** screw and the **VENT** screw. Allow the gear lubricant to drain into the container. As the lubricant drains, catch some with your fingers from time-to-time, and rub it between your thumb and finger to determine if any metal particles are present. If metal is detected in the lubricant, the unit must be completely disassembled, inspected, and the damaged parts replaced. Check the color of the lubricant as it drains. A whitish or creamy color indicates the presence of water in the lubricant. Check the drain pan for signs of water separation from the lubricant. The presence of any water in the gear lubricant is bad news. The unit must be completely disassembled, inspected, the cause of the problem determined, and then corrected.

2- Model with Cam-Shift: Shift the lower unit into **FORWARD** gear. Model with E-Z shift: Shift the lower unit into **NEUTRAL**.

Raise the outboard unit upward until the tilt lever can be actuated, and then engage the tilt stop.

SAFETY WORDS

As a safety measure to prevent accidental movement of the outboard while service work is



2

being performed, it is **STRONGLY** recommended a few minutes be used to make a safety support tool as shown in the accompanying illustration. The tool may be made from any metal bar stock or small channel iron of suitable size, with a 3/8" (9.53 mm) hole drilled through at each end and 14" (35.6 cm) apart, as shown. Cut-off the head of a 3/8" bolt about 2-1/2" (6.4 cm) long.

Drill a hole through each bolt for a cotter pin. Secure the bolts through the holes made in the bar stock with two nuts, one on each side of the bar. The tool is now ready for installation, one end through the clamp bracket and the other end through the tilt stop bracket. Secure each end of the tool in place with a washer and cotter pin. The lower unit may now be serviced or other work performed with confidence and in safety.

Propeller Removal

SAFETY WORDS — ALL MODELS

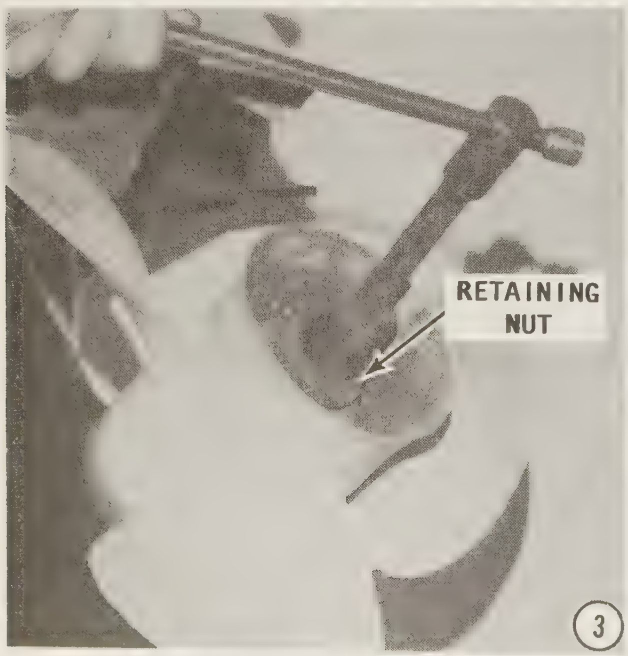
An outboard engine may start very easily. Therefore, anytime the propeller is to be removed or installed, check to be sure:

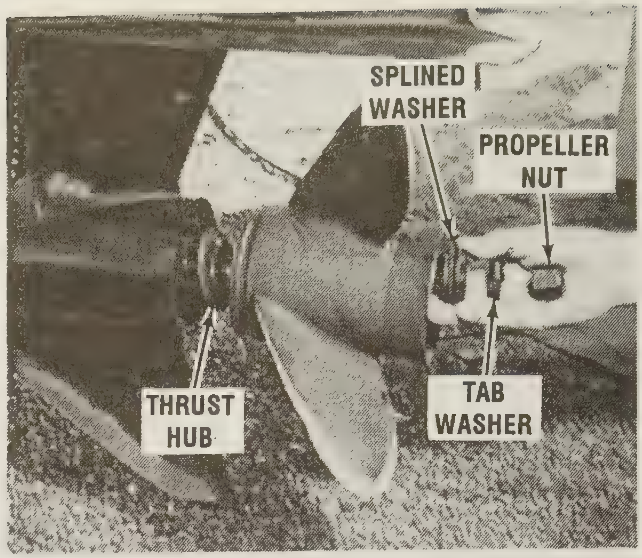
a- Key switch is in **OFF** position.

b- Spark plug wires are disconnected.

c- Electrical leads disconnected at the battery terminals.

3- Bend the locking tabs forward out of the locking washer. Some lower units have a locknut installed instead of a lockwasher.





Propeller and associated parts for the lower units covered in this chapter.

Never pry on the edge of the propeller. Any small distortion will affect propeller performance.

Remove the propeller nut by first placing a block of wood between one of the propeller blades and the anticavitation plate to prevent the propeller from turning, and then remove the nut. Remove the splined washer. Remove the outer thrust hub from the propeller shaft. If the thrust hub is stubborn and refuses to budge, use two **PADDED** pry bars on opposite sides of the hub and work the hub loose. **TAKE CARE** not to damage the lower unit. Remove the propeller. If the propeller is "frozen" to the shaft, perform the following procedures to break it loose.

"Frozen" Propeller

4- If the propeller is frozen to the shaft, heat must be applied to the shaft to melt out the rubber inside the hub. Using heat will destroy the hub, but there is no other way. As heat is applied, the rubber will expand and the propeller will actually be blown from the shaft. Therefore, **STAND CLEAR** to avoid personal injury.

5- Use a knife and cut the hub free of the inner sleeve.

6- The sleeve can be removed by cutting it with a hacksaw, or it can be removed with a puller. Again, if the sleeve is frozen, it may be necessary to apply heat. Remove the thrust hub from the propeller shaft.

Procedures for propeller installation are given at the end of this chapter, after the lower unit has been installed.

Remove the inner thrust hub. If this hub is also stubborn, use padded pry bars and work the hub loose. Again, **TAKE CARE** not to damage the lower unit.

7- Check to be sure the lower unit is in the proper gear according to the following paragraphs.

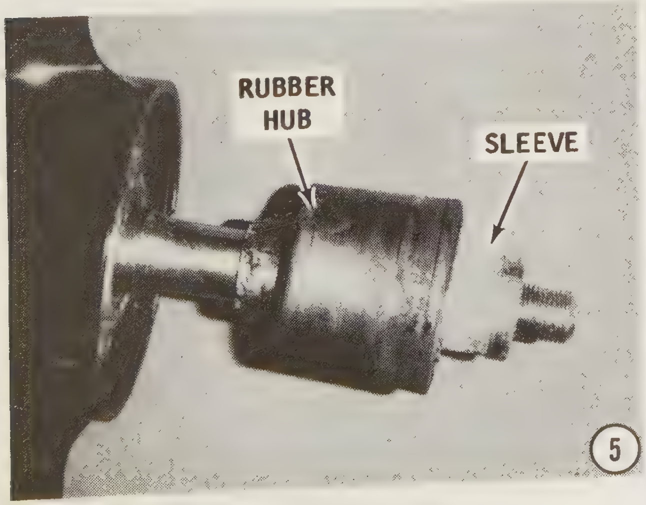
Cam Shift Only

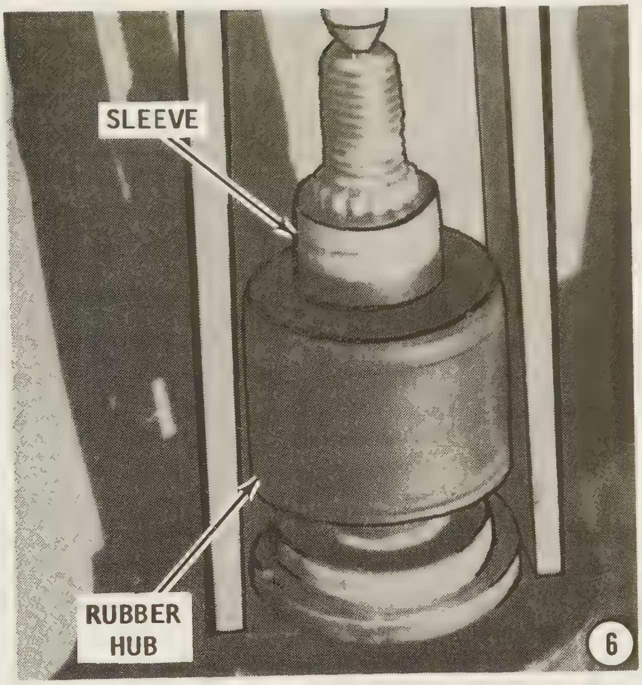
Check to be sure the lower unit is in **FORWARD** gear.

E-Z Shift

Check to be sure the lower unit is in the **NEUTRAL** position.

Scribe a line between the trim tab and the anti-cavitation plate. This mark will ensure the trim tab will be installed back at the original angle. Remove the plastic cap from the rear

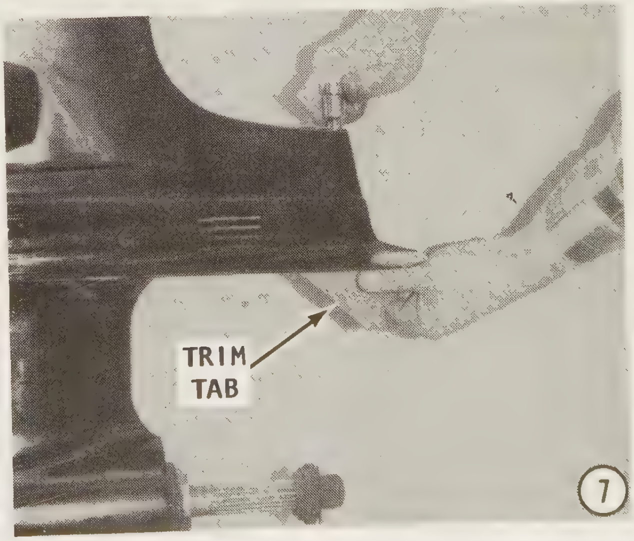


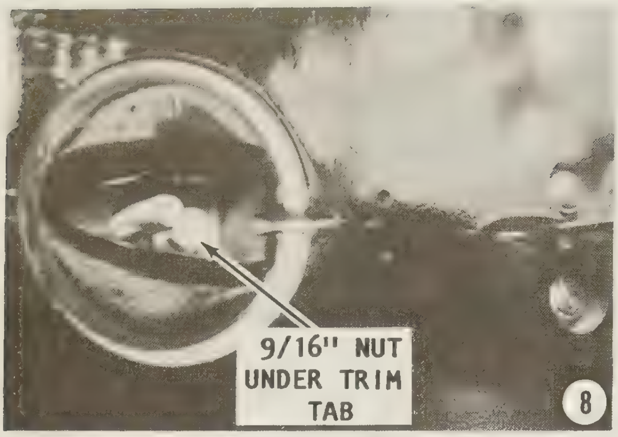


edge of the exhaust housing. Insert the proper size wrench into the hole and remove the trim tab adjusting bolt and trim tab from the lower unit.

All Units Except 275hp

8- Remove the bolt from the recess where the trim tab was mounted. Remove the two locknuts and washers from the bottom middle section of the anti-cavitation plate. Remove the locknut and washer on the front end of the lower unit. Loosen, but **DO NOT** remove, the 5/8" locknuts on each side of the exhaust housing. Loosen the nuts as far as the stud threads will allow. Separate the lower unit from the exhaust housing as far as the studs and nuts will permit. Hold the lower unit from falling and at the same time remove the two nuts. Remove the lower unit from the intermediate housing.

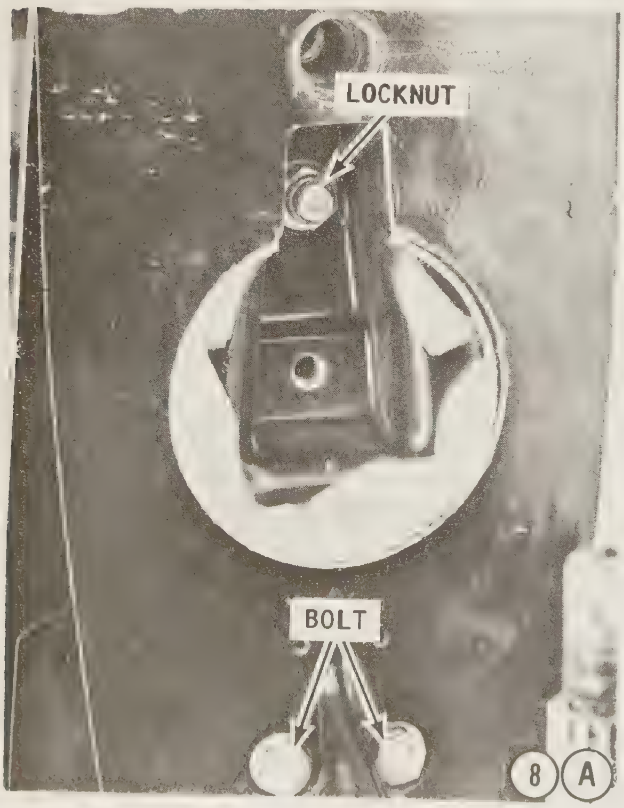




Model 275hp Only

8A- Remove the center bolt from the anode, and then the anode. Remove the nut and washer from inside the anode plate cavity. Remove the two bolts and washers from the bottom of the anti-cavitation plate. On the forward end of the lower unit housing, remove the bolt and washer securing the lower unit to the intermediate housing. Some units may have a stud and nut in this same location.

Now, slowly **LOOSEN,** but **DO NOT** remove, the two mounting locknuts from each side of the lower unit. Loosen all four nuts a little at-a-time to prevent damage to the drive shaft housing. As the nuts are loosened, allow the lower unit to separate from the intermediate



housing. After the lower unit is moved downward a short distance, disconnect the speedometer hose from the lower unit fitting. Hold the lower unit, and then remove all four nuts. Have an assistant help support and lift the lower unit because these lower units weigh approximately 90 pounds. Separate the lower unit from the intermediate housing. **SLOWLY** lower the unit and at the same time, guide the driveshaft out of the intermediate housing.

9-4 WATER PUMP SERVICE

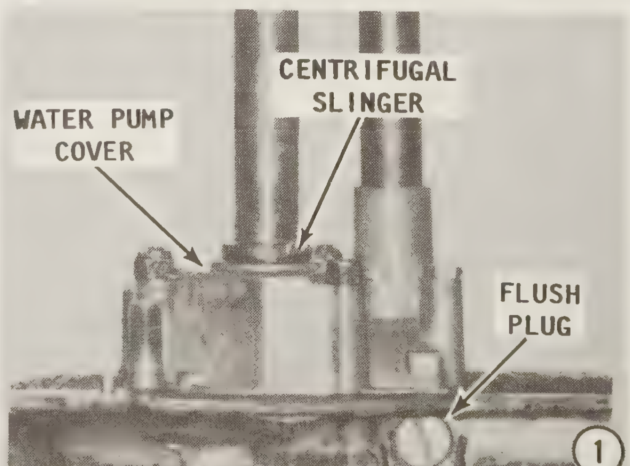
Removal and Disassembly
High Volume Unit
Models 135hp thru 200hp
(See Page 9-10 for
High Pressure Unit)

1- Slide the centrifugal slinger on top of the water pump cover up and free of the driveshaft. Lift out the water tube guide and seal from the pump cover. Remove the three retaining nuts and washers securing the pump cover to the pump base.

Some model units may have three nuts and one bolt securing the pump cover. Use two screwdrivers, one on each side, and pry the pump cover off the studs. If the cover is "frozen" to the pump, it may be necessary to use a chisel to break the cover loose from the studs.

The seal is very difficult to remove. If the seal and insert is damaged, or unfit for further service, the recommendation is to replace the pump cover. A kit is available from the local dealer and will include a new seal -- installed, and a new insert. The new insert will slip easily into place. If the cover kit is not available, proceed to remove the seal and insert as follows:

Use a punch and hammer and drive the pump insert out of the pump cover. Drive the



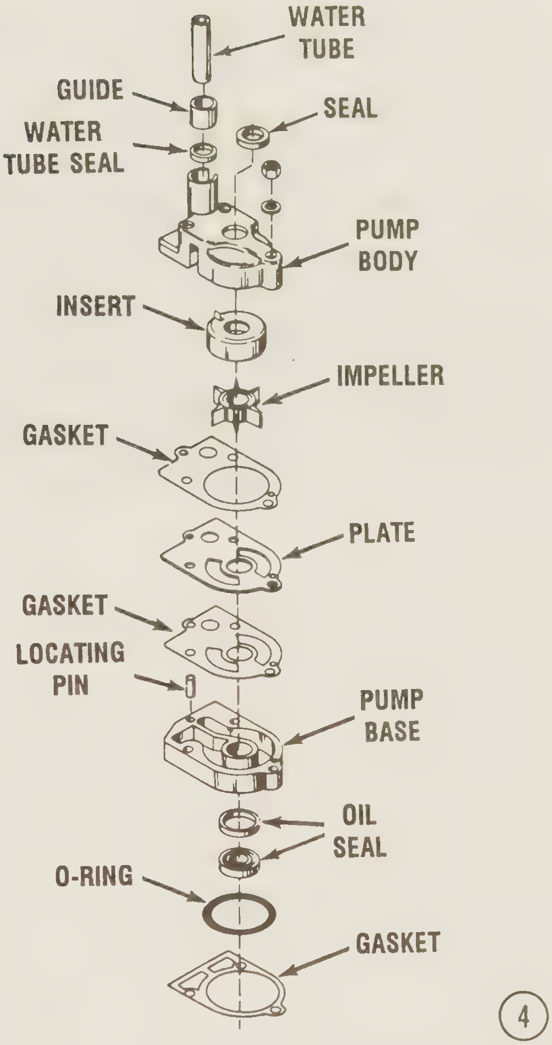
pump cover seal out of the cover, from the insert side.

2- Remove the impeller from the driveshaft. If the impeller is stubborn, it may be necessary to use a punch and hammer to drive the impeller upward and off the driveshaft. If a punch and hammer will not move the impeller, the only answer is to use a chisel and split the impeller. Splitting the impeller is not really "Bad News" because a new impeller should **ALWAYS** be installed when the lower unit is opened. Remove and **SAVE** the impeller drive pin -- Woodruff Key -- from the flat area of the driveshaft

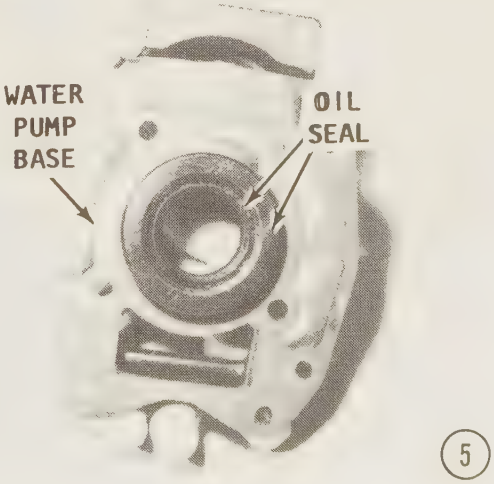
3- Lift upward on the face plate and remove it and the gasket from the mounting studs. Clean any gasket material from the face plate and from the pump base.

4- Use two screwdrivers and pry the water pump base from the lower unit. Remove and discard the gasket under the base.

5- Inspect the condition of the two oil seals housed in the water pump base. If the oil seals are unfit for further service, the manufacturer recommends the pump base be replaced. The base is available in kit form and will include new seals. If the kit is not available, proceed to remove the seals as follows: remove the oil seal



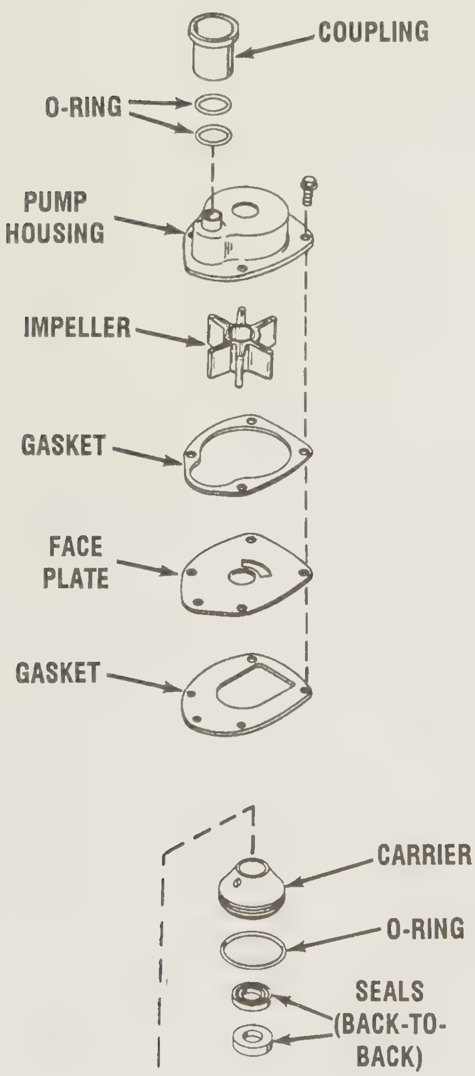
from the pump base by prying or driving them away from the impeller side of the pump base. Remove the **O**-ring from the groove in the pump base. Clean any gasket material from the upper and lower surfaces of the pump base.



Water Pump
Removal and Disassembly
Models 225hp and 275hp

First, These Words

The two exploded drawings -- one for the Model 225hp unit -- the other for the Model 275hp on this page will prove most helpful in understanding the order of parts to this water pump. Disassembly and assembly is very straight forward. Therefore, the following paragraphs, along with the drawings, should speed the work and have the task of rebuilding either pump completed in the shortest time.

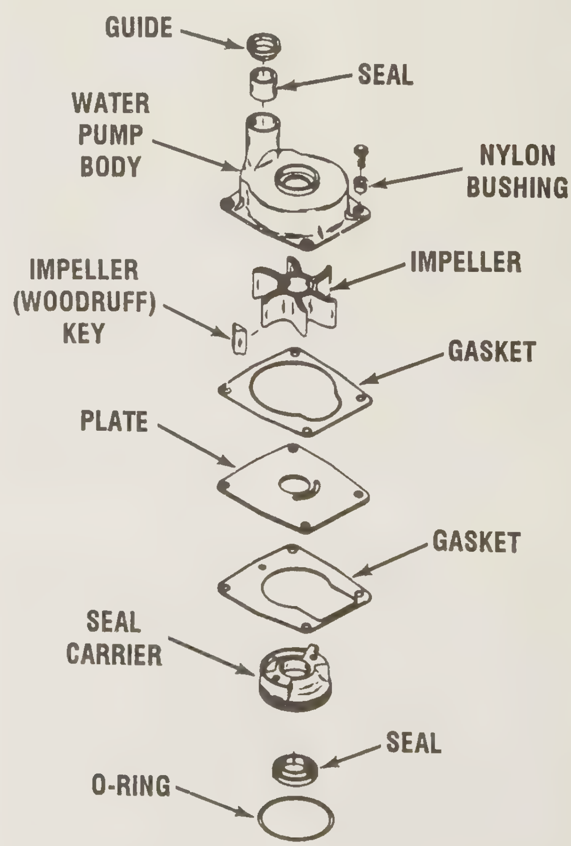


Exploded drawing of the high pressure water pump installed on the Model 225hp. Major parts have been identified.

a- Lift out the water tube guide and seal from the pump cover. Remove the four retaining bolts, washers and nylon bushings securing the pump cover to the lower unit. Use two screwdrivers -- one on each side -- and pry the pump cover off the studs. If the cover is "frozen" to the pump, it may be necessary to tap on the cover, with a soft head mallet, to break it loose from the plate.

If the seal in the cover is damaged, or unfit for further service, the recommendation is to replace the pump cover. A kit is available from the local dealer and will include a new seal -- installed. If the cover kit is not available, remove the seal using a hammer and punch. Drive the pump cover seal out of the cover, from the impeller side. Tap the new seal into place using a deep socket the same size as the seal.

b- Slide the impeller up and free of the driveshaft. If the impeller is stubborn, it may be necessary to use a punch and hammer to drive the impeller upward and off the shaft. If



Exploded drawing of the high pressure water pump installed on the Model 275hp. Major parts have been identified.

corrosion has developed on the driveshaft, use a piece 300 grit paper and remove the corrosion to make the task of removing the impeller much easier.

In an extreme situation, it may be necessary to split the impeller with a chisel and hammer. Splitting the impeller is not really "Bad News", because a new impeller should **ALWAYS** be installed when the lower unit is opened. Be extra careful not to damage the driveshaft or key in the impeller.

After the impeller has been removed, lift out the impeller drive (Woodruff) key from the driveshaft. Lift up on the impeller plate and slide the plate free of the driveshaft. Clean **ALL** gasket material from both sides of the plate.

c- Remove the seal carrier from the driveshaft by inserting two pump cover bolts partially into the seal carrier -- one on each side. Using a pair of screwdrivers under the heads of the bolts, pry the seal carrier up and out of the pocket in the housing. Remove the seal and **O-**ring from the carrier.

VERY SPECIAL GOOD WORDS

If the only work to be performed on the lower unit is servicing the water pump, proceed directly to Section 9-7, Water Pump Installation.

If further work is to be performed on the Cam-Shift lower unit, continue with Section 9-5, Servicing Cam-Shift Units, beginning on this page -- next section.

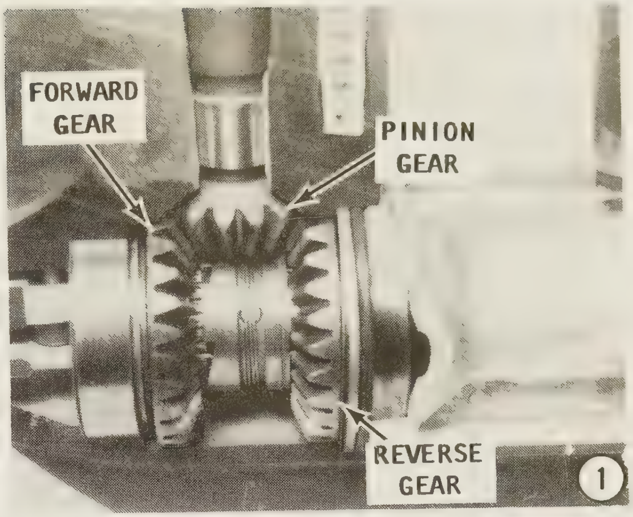
If further work is to be performed on the E-Z Shift lower unit, continue with Section 9-6, -- Servicing E-Z Shift Units -- beginning on Page 9-34.

9-5 SERVICING CAM-SHIFT LOWER UNIT

The following procedures outline complete detailed instructions to remove virtually all parts of the lower unit. If a particular part is found to be in satisfactory condition and does not require removal, simply skip the steps involved and proceed with the required tasks to restore the lower unit to operational efficiency.

GOOD WORDS

The reverse gear-to-pinion gear backlash and the forward gear-to-pinion gear backlash should be checked **PRIOR** to disassembling the lower unit.



1- The reverse gear backlash can be checked only at a point of propeller shaft rotation where it is not possible to shift the neutral gear into reverse, as outlined in the following procedure.

Three hands are necessary for the backlash check. Therefore, obtain the help of an assistant.

Slowly rotate the propeller shaft and at the same time attempt to shift into the reverse gear position. Once this position is reached:

a- Pull up on the driveshaft.

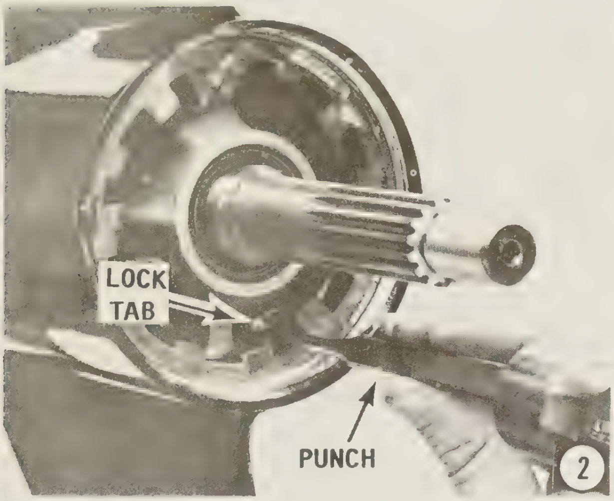
b- Pull outward on the propeller shaft.

c- Hold pressure on the lower shift shaft towards reverse.

d- Lightly rotate the propeller shaft **CLOCKWISE** and **COUNTERCLOCKWISE.**

The amount of free "play" felt is the reverse gear-to-pinion gear backlash. For all powerheads covered in this manual, the correct amount of backlash allowable is 0.030-0.050" (6.762-1.27mm). Record the amount of backlash felt because it may affect shimming of the reverse gear during assembly

Repeat Step 1 to check the backlash of the forward gear, except push in on the propeller shaft instead of pulling outward. Allowable backlash for the forward gear varies, depending on the Model being serviced. Therefore, consult the table in the Appendix.



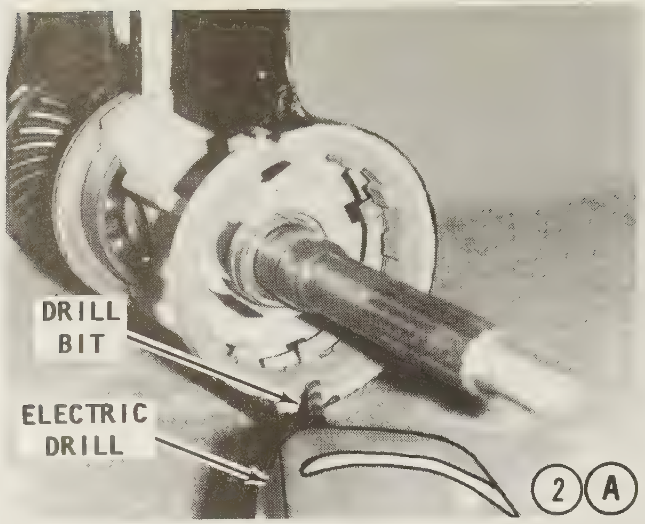
Bearing Carrier and Propeller Shaft Removal

2- Bend the locking tab(s) away from the cover nut recess using a punch or screwdriver.

Slide the large end of the cover nut tool, P/N 91-73688, down over the propeller shaft and into the cover nut. Be **SURE** the lugs on the tool are properly indexed and fully engaged with the cover nut. Now, using a large socket or wrench, turn the cover nut tool **COUNTER-CLOCKWISE** and remove the cover nut.

If the cover nut refuses to budge, it may be necessary to carefully apply heat to the lower unit around the outside of the nut.

Preparing to use the special tool described in Step 2 of the text.



2A- If the nut still refuses to loosen, a last resort is to drill the nut as shown in the accompanying illustration.

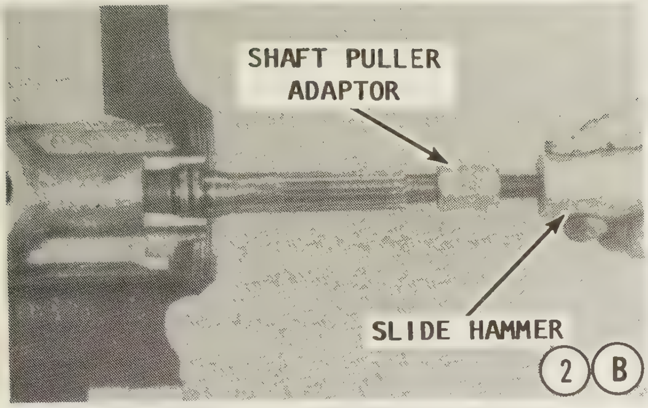
NOW, THESE WORDS

Three methods are available to remove the bearing carrier from the Cam-Shift lower unit. The first and fastest method is to mate an adapter onto the end of the propeller shaft with a slide hammer attached. This procedure is explained in Step 2B.

The second method involves the use of a slide hammer and a long puller jaws to remove the carrier from the lower unit as outlined in Step 2C.

The third and least desirable method is to use a mallet to actually drive the lower unit off

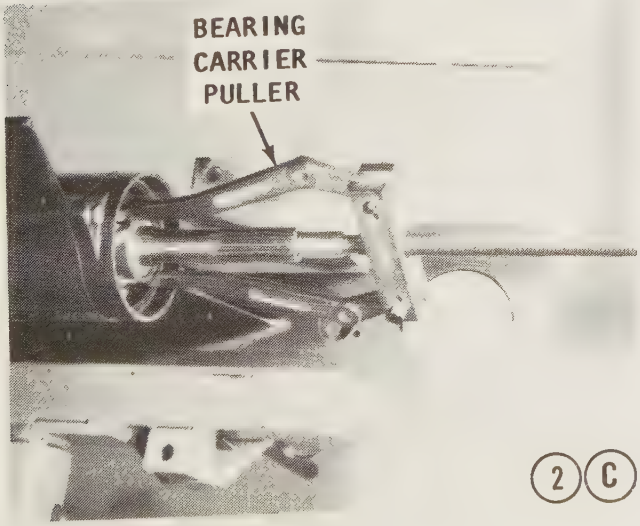
"Frozen" bearing carrier nut after being sacrificed and drilled out, thus saving more expensive parts.

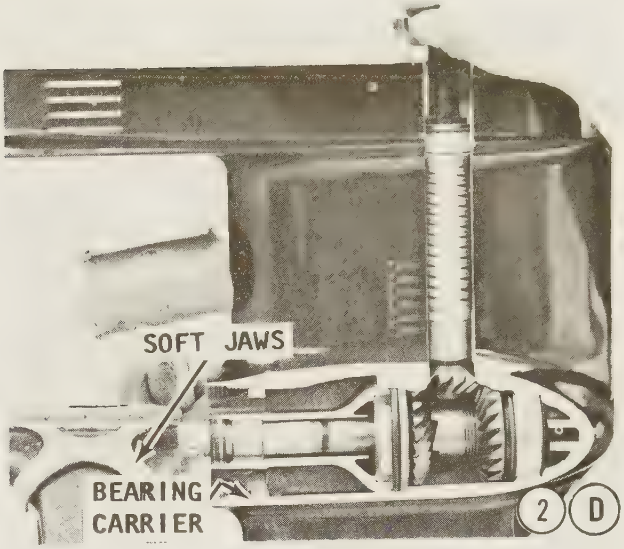


the carrier. The procedures involved in this method are covered in Step 2D.

2B- The first method of removing the bearing carrier is to use a shaft puller adapter and a slide hammer, as shown in the accompanying illustration. Thread the adapter onto the propeller shaft as far as possible. Next, thread the slide hammer into the adapter. Operate the slide hammer and pull the bearing carrier out of the lower unit housing.

2C- As explained, this step is an alternate method for removing the bearing carrier from the lower unit. Obtain a long jaws puller P/N C-91-46086A1. Place the ends of the puller, inside the lip on the bearing carrier. Screw the puller bolt up against the end of the propeller shaft. If needed, slide the propeller thrust hub (large splined washer), onto the propeller shaft to wedge the puller jaws tight against the lip of the bearing carrier. Attach slide hammer P/N 91-34569A1 to the end of the puller. Operate the slide hammer and pull the bearing carrier out of the lower unit. The propeller shaft may remain in the lower unit or come out with the bearing carrier.





2D- The third and least desirable method is actually a reverse procedure. Instead of pulling the bearing carrier free of the lower unit housing, the housing is driven from the bearing carrier. The services of an assistant will **ENSURE** the lower unit housing will be supported when it finally comes free of the carrier.

Begin by clamping the propeller shaft in a vise equipped with soft jaws in the horizontal position. Use a mallet and strike the lower unit with quick sharp blows midway between the anti-cavitation plate and the propeller shaft. This action will drive the lower unit off the bearing carrier. **TAKE CARE** not to drop the lower unit when the unit finally comes free of the carrier.

Now, if the lower unit refuses to move, it may be necessary to **CAREFULLY** apply heat to the lower unit in the area of the carrier and at the same time attempt to move it off the carrier.

Remove the propeller shaft and bearing carrier from the vise. Slide the propeller shaft out of the bearing carrier from the rear to the front. Set the assembly aside for disassembly later.

Bearing Carrier Disassembling

3- Inspect the two seals and the condition of the needle bearing at the rear end of the carrier. If the seals have failed and have allowed water to enter the lower unit, the needle bearing is no longer fit for further service. If the bearing does not roll freely or shows any sign of corrosion, clamp the carrier in a vise equipped with soft jaws. Obtain and use Slide Hammer P/N C-91-34569A1 to pull the bearing free of the carrier.

3

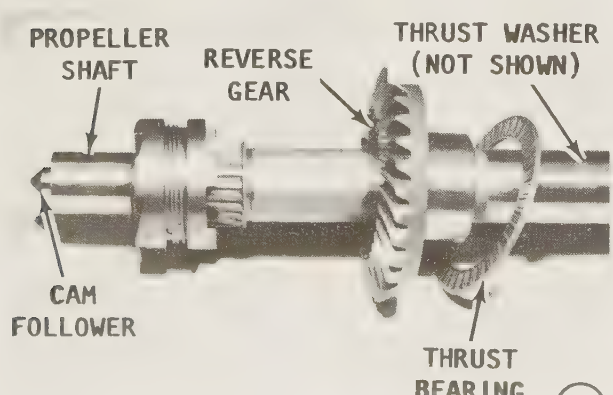
Use a screwdriver and remove both seals. These seals should have been installed back-to-back. The outer seal prevents water from entering the lower unit and the other seal prevents oil from escaping.

Obtain Bearing Removal and Installation Kit P/N C-91-31229A-5. Obtain Mandrel P/N C-91-36569 and Driver Rod P/N C-91-37323, or a suitable substitute mandrel. Insert the removal tools into the forward end of the carrier and press the needle bearing out the rear end of the carrier.

Remove and discard the large O-ring around the carrier.

Propeller Shaft Disassembling

4- Tilt the forward end of the propeller shaft up slightly to prevent loss of the cam follower and very small parts behind the follower into the depths of the housing. Pull the shaft



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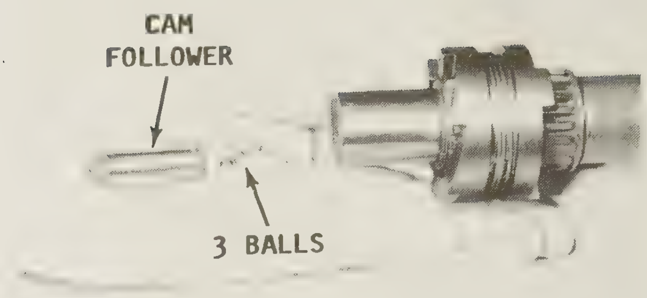


5

free of the housing. The reverse gear, a thrust bearing, and a thrust washer will come out with the shaft.

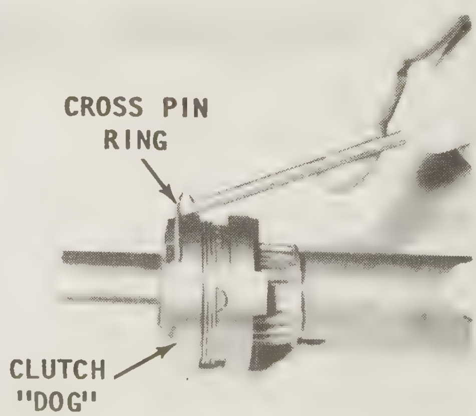
SPECIAL WORDS

Note the absence of any shim material behind the reverse gear. A backlash specification is given by the manufacturer. However, an adjustment is not possible by adding or removing shim material behind the reverse gear.

5- Slide the cam follower, and then the three very small balls from the forward end of the propeller shaft.

6- Insert a thin blade screwdriver or an awl under the first coil of the cross pin ring, and then rotate the propeller shaft to unwind the spring from the sliding clutch. **TAKE CARE** not to overstretch the spring anymore than absolutely necessary.

7- Push the cross pin clear of the clutch "dog" and the propeller shaft. **BE PREPARED** to catch the guide block and spring when they



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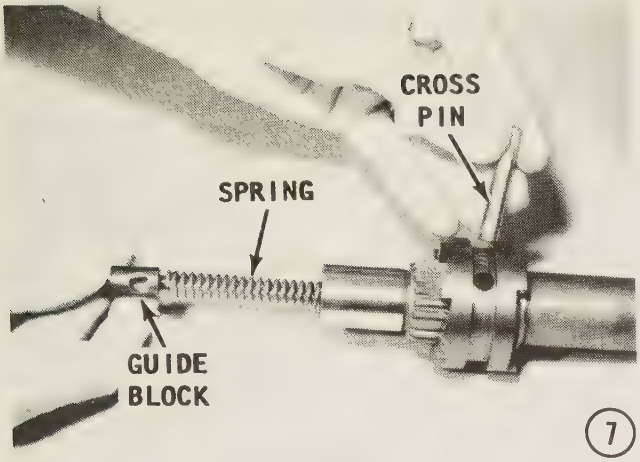
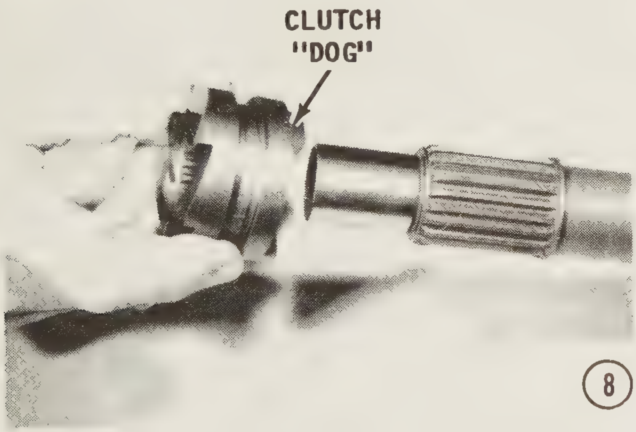




"fly" free from the end of the propeller shaft.

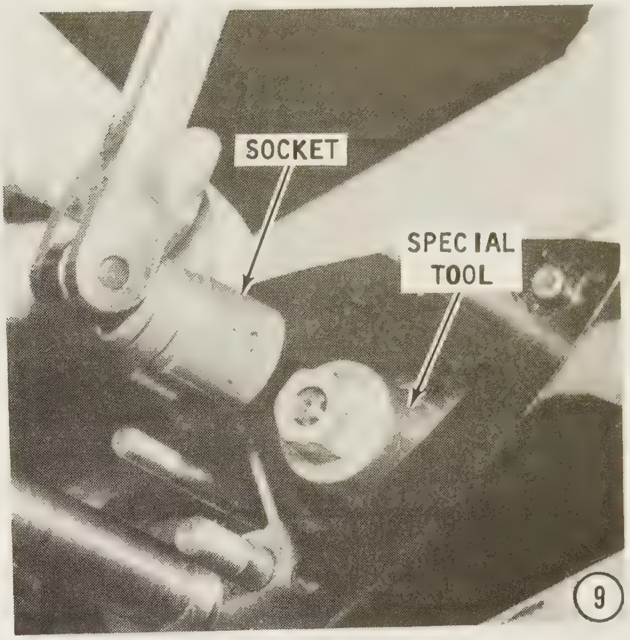
8- Slide the clutch "dog" from the propeller shaft.

Shift Shaft Removal

9- The bearing carrier, propeller shaft, and forward gear **MUST** be removed prior to removing the shift shaft and shift cam. Obtain Shift Shaft Bushing Removal tool P/N 91-31107. Use the special tool and the proper size socket to un-thread the bushing. If the special tool is not available, a blunt punch indexed in one of the slots near the outer edge and a hammer may be used to unthread the bushing. Work **CAREFULLY**, using sharp, short, quick blows with the hammer. Lift the shift shaft and bushing from the lower unit.

Pinion Gear and Driveshaft

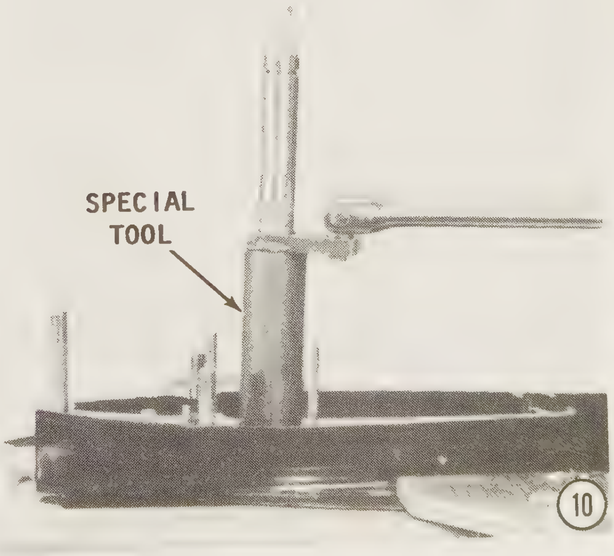
10- Obtain Bearing Retainer Nut Tool C-91-43506. Slide the special tool down the driveshaft until the tool is indexed over the nut. Use a breaker bar on the special tool and loosen the nut. Slide the special tool free of the driveshaft, and then back the nut off and clear of the driveshaft.

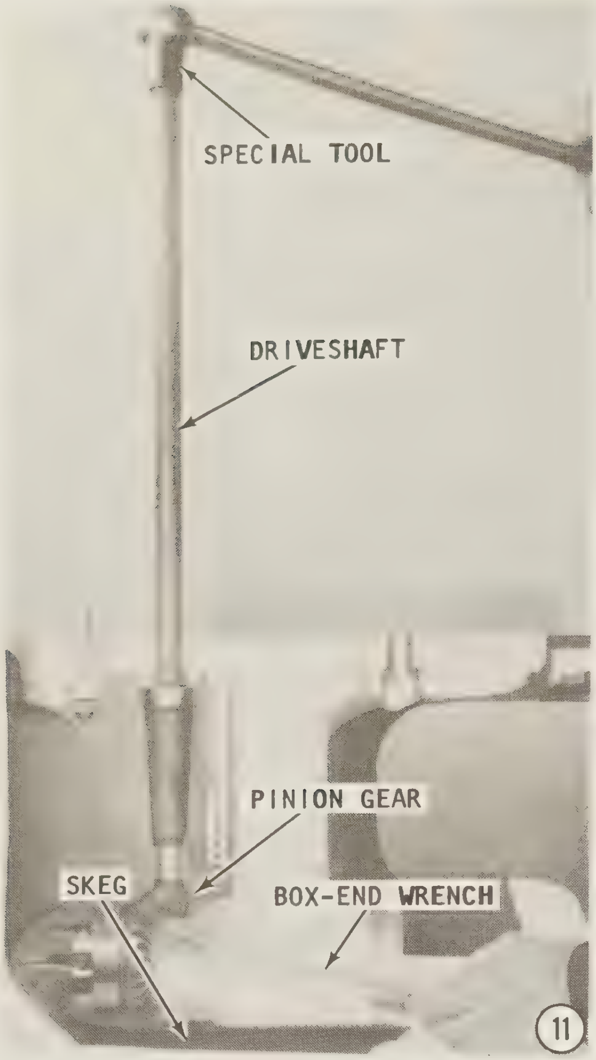


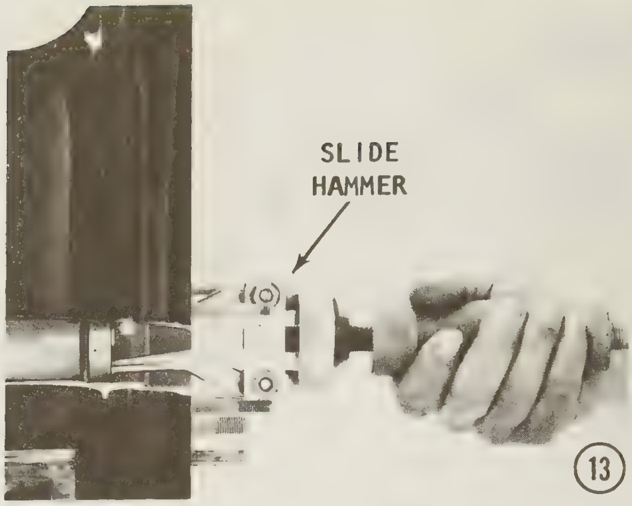
Select a box end wrench the same size as the pinion nut. This tool will be used to prevent the nut from turning as the driveshaft is rotated. Obtain Driveshaft Holding Tool C-91-34377A1.

11- Install the holding tool onto the end of the driveshaft. Now, with the box end wrench on the pinion gear nut, rotate the driveshaft **COUNTERCLOCKWISE** until the pinion gear nut is free. Remove the nut and the pinion gear assembly.

12- Pull the driveshaft straight up and out of the lower unit. Reach in through the propeller shaft opening and remove the pinion gear. If the driveshaft refuses to come out, an alternate method is to first clamp the driveshaft in a vise equipped with soft jaws. Next, use a







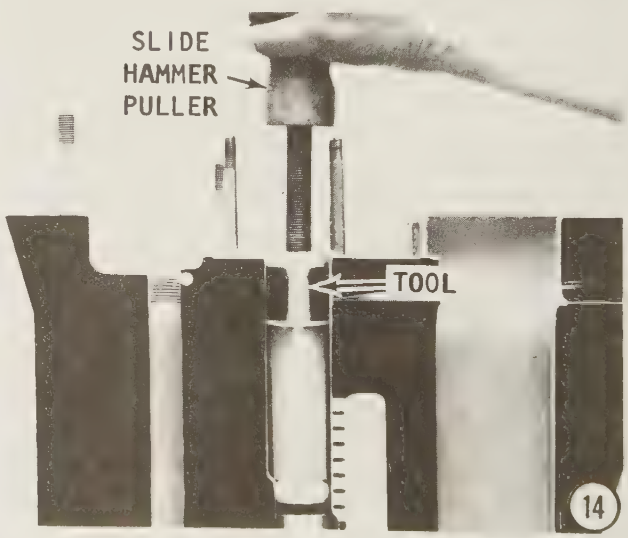
block of wood to protect the lower unit and drive the lower unit off the driveshaft. If this method is used, **TAKE CARE** to prevent the lower unit from falling when it finally comes free of the driveshaft.

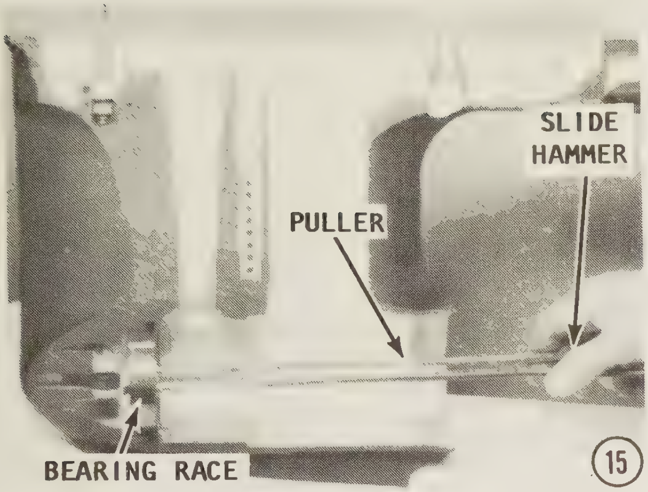
13- Use a slide hammer and remove the driveshaft tapered bearing race. Save the shim material from under the tapered bearing race. The same amount of shim material will probably be used during assembling.

14- Obtain Water Pump Cartridge Puller P/N C-91-27780. Use the puller to remove the lubrication sleeve from the lower unit. Some units may not have this sleeve installed. Set the driveshaft aside for disassembling later.

Forward Gear and Bearing Removal

15- After the pinion gear is removed, the forward gear and bearing can be lifted out of the lower unit. The tapered bearing race will remain within the lower unit. **DO NOT** attempt





to remove the bearing race unless it is unfit for further service, or the forward gear backlash is far too excessive. Remove the forward bearing race and shim material using a slide hammer.

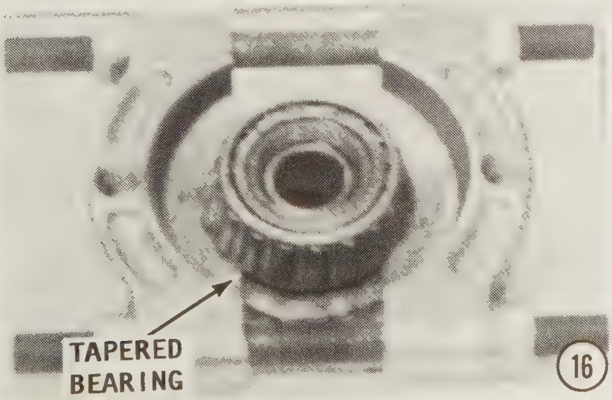
Separating Forward Gear From Bearing

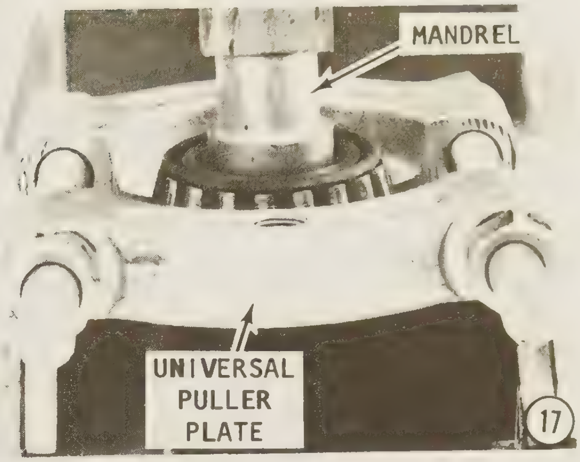
The forward gear bearing does **NOT** have to be removed to perform an adequate job of cleaning and inspecting. Therefore, it is not necessary to separate the bearing and gear unless either is unfit for further service.

16- Position Universal Puller Plate P/N C-91-37241 between the forward gear and the tapered bearing. Place the puller plate and gear on a press with the gear on the bottom. Press the gear out of the bearing with a suitable mandrel. If the bearing cannot be removed, clamp the forward gear in a vise equipped with soft jaws. Use a punch and hammer to drive the roller bearing out of the forward gear.

Driveshaft disassembling

DO NOT remove the driveshaft bearing unless it is no longer fit for further service. If the tapered bearing requires replacement, the bearing race **MUST** also be replaced.





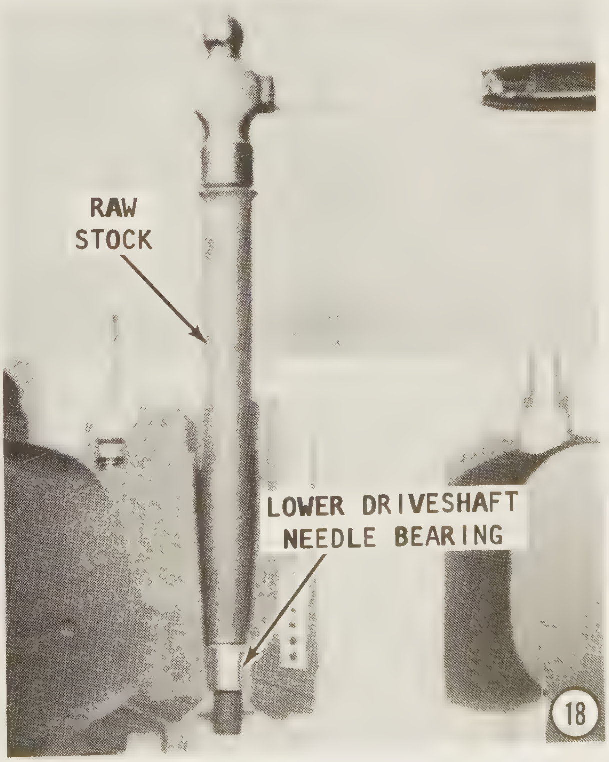
17- Position the driveshaft and Universal Puller Plate P/N C-91-37241 on a press, as shown. Press the driveshaft out of the tapered bearing hub.

BAD NEWS

Once the bearing has been removed it **CANNOT** be used a second time because the roller cage will be damaged during the removal operation. In this case the race will have to be replaced because the bearing and race are a matched set.

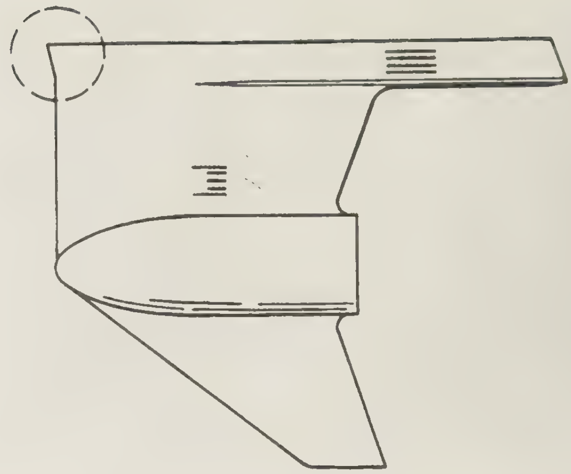
Driveshaft Needle Bearing Removal

18- After the driveshaft is removed from the lower unit housing, examine the needle bearing



assembly in the bottom of the housing. **DO NOT** remove the bearing assembly if it is found to be serviceable. If the bearing is removed, a new bearing **MUST** be installed because the old bearing will be severely damaged when it is removed from the housing bore.

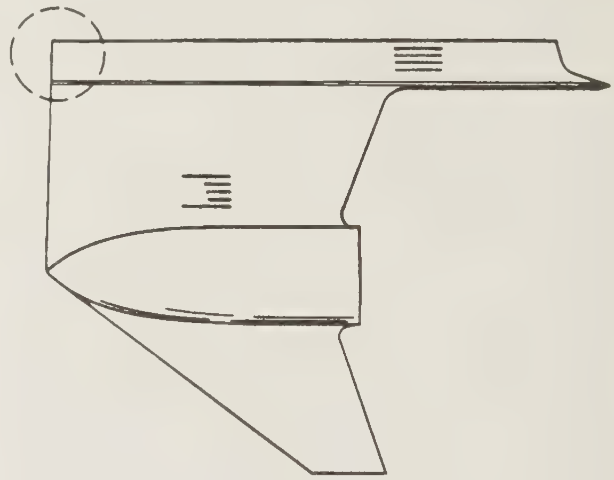
There are two different lower unit housings matched with the Model 150 XR6 and 150 Magnum III powerheads. Examine the forward end of the housing and compare it with the illustrations shown. Determine if the housing is an "Early" or "Late" model unit. This information will be needed when purchasing a new bearing assembly because the two housings use slightly different size bearing assemblies.



EARLY MODEL

MORE BAD NEWS

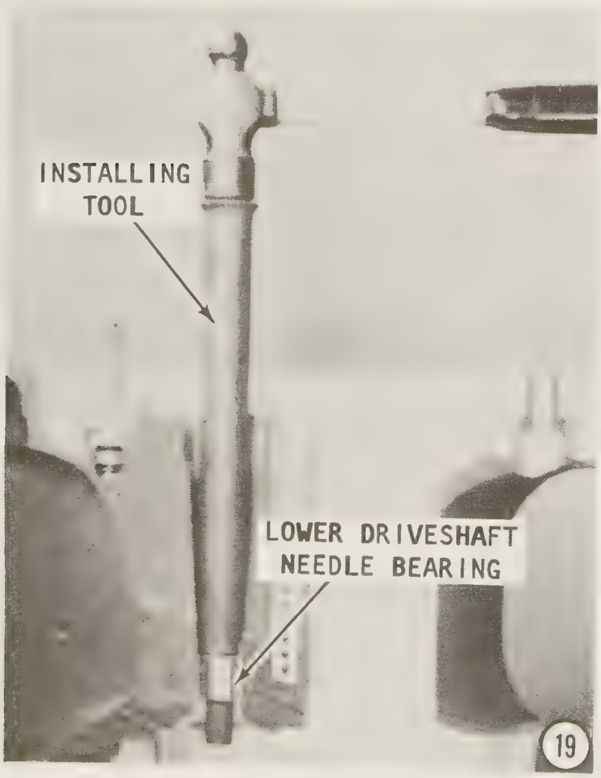
If the driveshaft needle bearing seized, and the bearing race has spun inside the case. A new lower unit housing **MUST** be purchased.

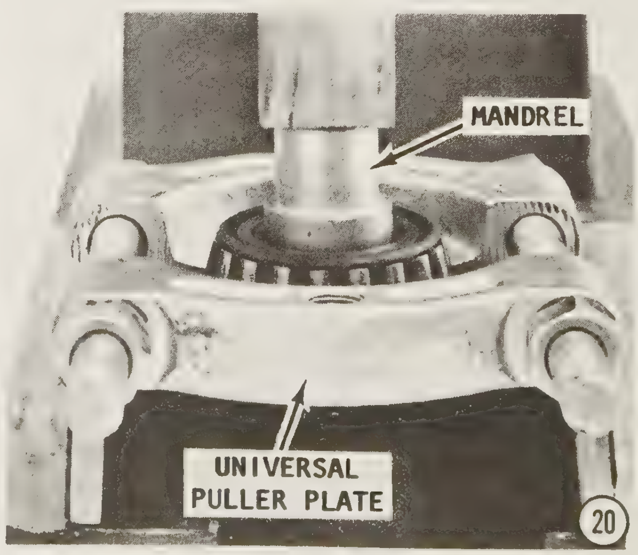


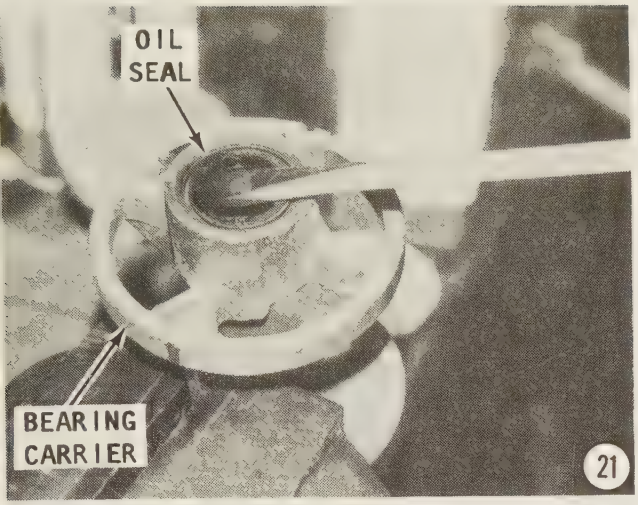
LATE MODEL

Identification of the lower unit housing for the XR6 and the Magnum III, to ensure the proper size driveshaft needle bearings are installed, as mentioned in the text.

19- Use a round piece of raw stock or an extension and socket the approximate size of the needle bearing assembly. Place the round stock on top of the needle bearing. Drive the bearing assembly down, out of the driveshaft bore and into the propeller shaft bore. Remove the loose bearing assembly from the propeller shaft bore.







Separating Reverse Gear From Bearing Carrier

20- Clamp the bearing carrier in a vise equipped with soft jaws. Remove and **DISCARD** the **O**-ring from between the bearing carrier and the thrust washer. Use a slide hammer and remove the reverse gear. If the reverse gear ball bearing remained in the bearing carrier, use a slide hammer and remove the bearing. If the bearing remained on the gear, remove the bearing using a Universal Puller Plate, P/N C-91-37241 and a suitable mandrel to press the gear free of the bearing.

21- Remove the seal by prying or driving it toward the rear. On some late model units, two seals are used. Set the assembly aside ready for cleaning and inspecting.

CLEANING AND INSPECTING

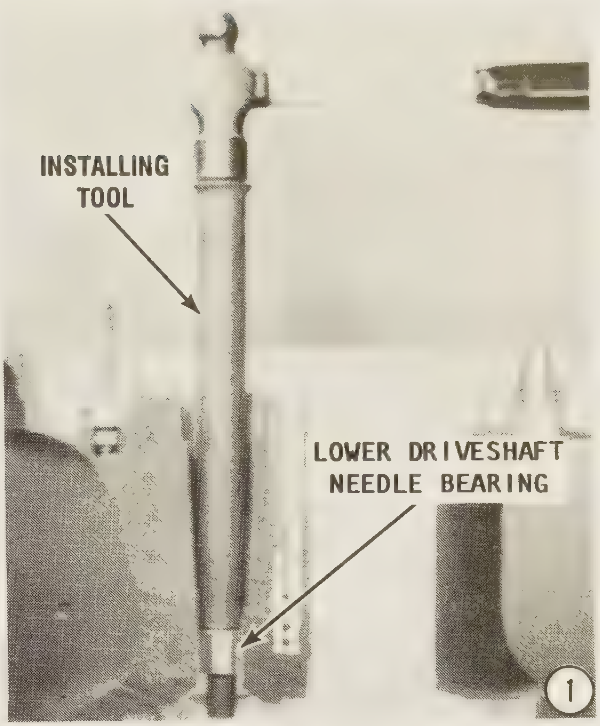
See Section 9-8, beginning on Page 9-67 for detailed, comprehensive procedures to clean and inspect virtually all parts of the lower unit.

ASSEMBLING CAM-SHIFT LOWER UNIT

The following procedures outline complete detailed instructions to install virtually all parts of the lower unit. If a particular part was found to be in satisfactory condition and was not removed, simply skip the steps involved and proceed with the required tasks to return the lower unit to efficient operation.

Lower Driveshaft Roller Bearing Model XR4 and Magnum II

If a new lower unit housing is being installed, the lower driveshaft roller bearing will already be in place.



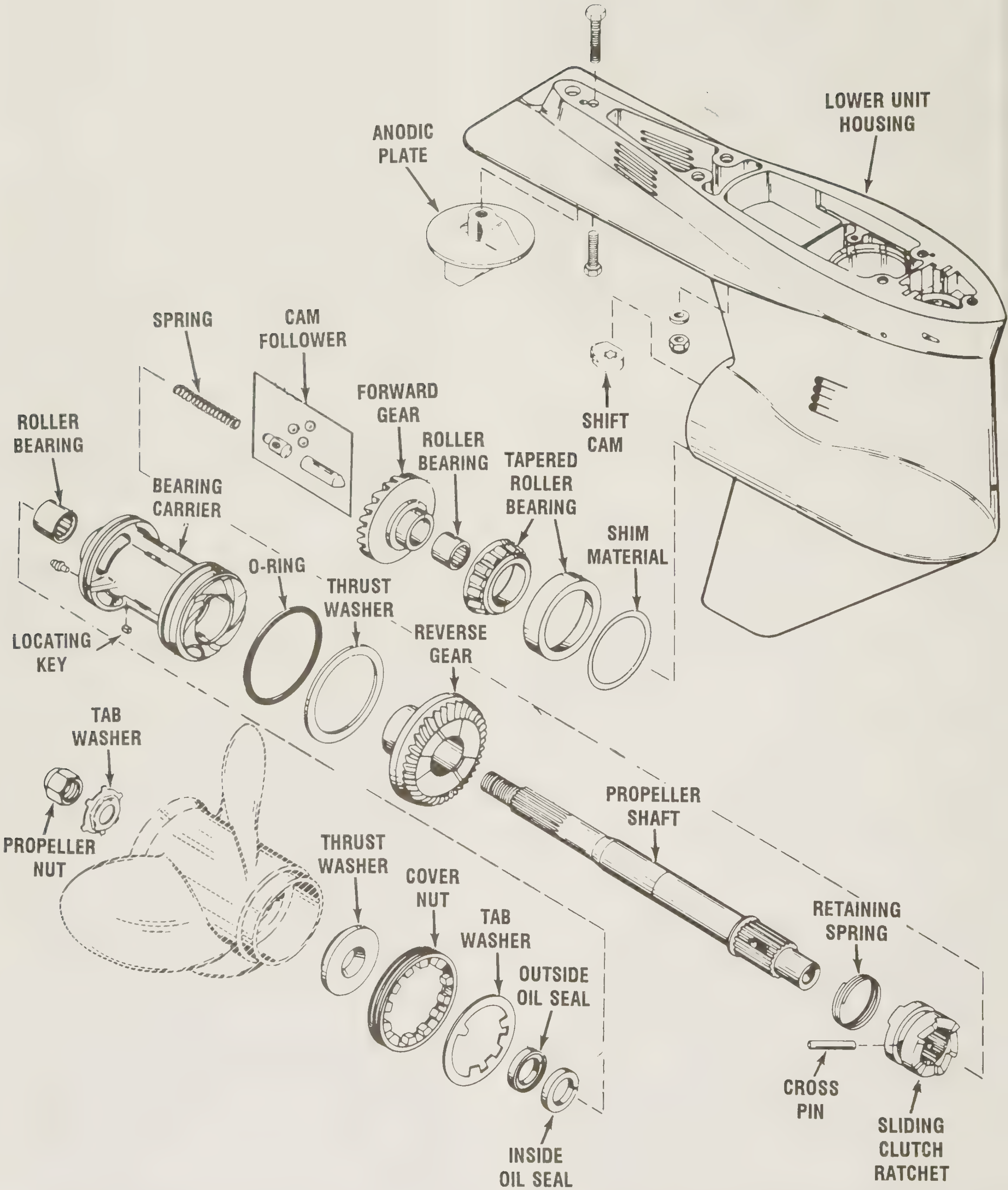
1- Obtain Bearing Removal and Installation Kit P/N C-91-312291. Place the drive shaft roller bearing over the driver head of the installation kit with the numbered side of the bearing **TOWARD** the shoulder of the driver head. Thread the driver rod from the kit into the drive head. Coat the needle bearing area of the driveshaft cavity with Quicksilver Formula 50-D lubricant, or equivalent.

Position the rod, driver head, and bearing into the lower unit driveshaft cavity. Place a pilot washer from the kit over the driver rod and slide it down into the driveshaft bearing cavity. Use a mallet to drive the roller bearing downward until it is approximately 1/16" (1.59mm), above the bottom end of the driveshaft cavity. Remove the driver rod, head, and pilot washer.

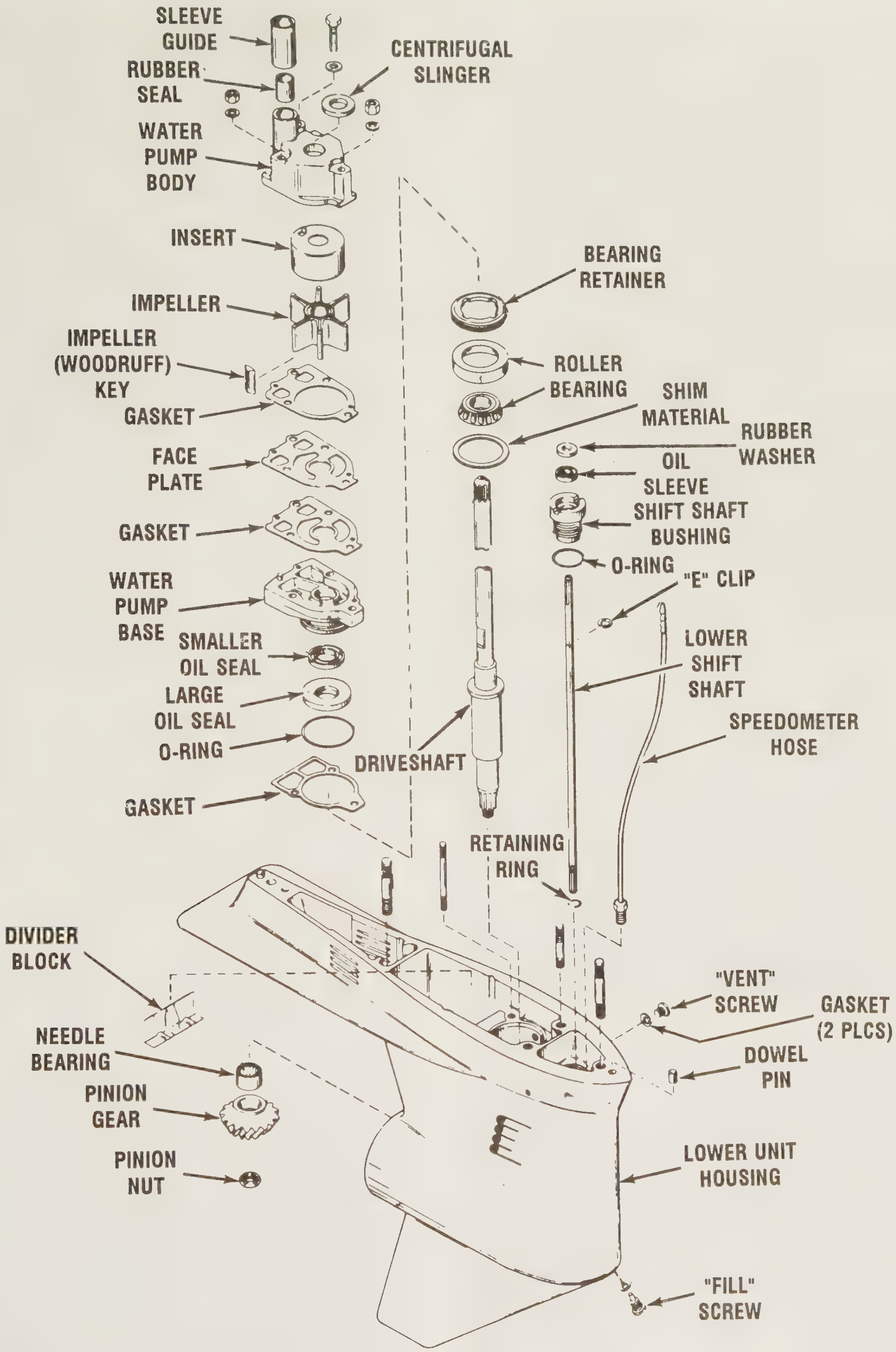
Lower Driveshaft Roller Bearing Models 150XR6 and Magnum III

If a new lower unit housing is being installed, the lower driveshaft roller bearing will already be in place.

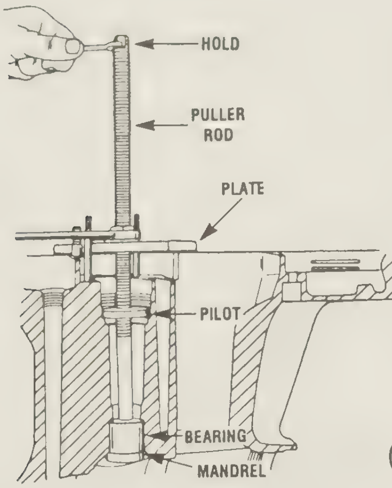
1A- The following instructions require the use of a Lower Driveshaft Bearing Installation Tool Kit P/N C-91-31229A5, or similar tools may be made from locally obtained hardware and raw stock. Place puller rod down through the driveshaft bore. Insert the bearing over the



*Exploded drawing of the propeller shaft and associated parts for the cam-shift lower unit matched with the **Model 150XR4, Magnum II, 150XR6,** and **Magnum III** powerheads covered in this section. Major parts have been identified. The driveshaft and its parts are shown on the facing page.*

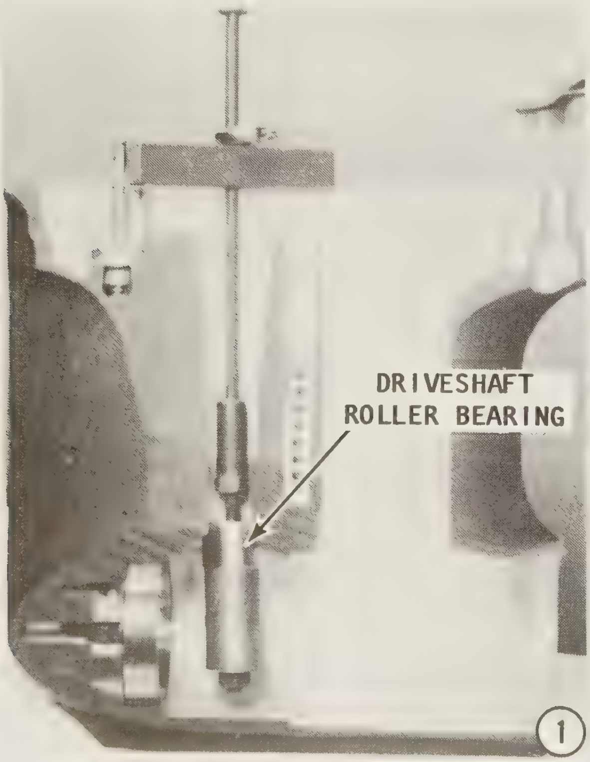


Exploded drawing of the driveshaft and associated parts for the cam-shift lower unit covered in this section. Major parts have been identified. The propeller shaft and its parts are shown on the facing page.

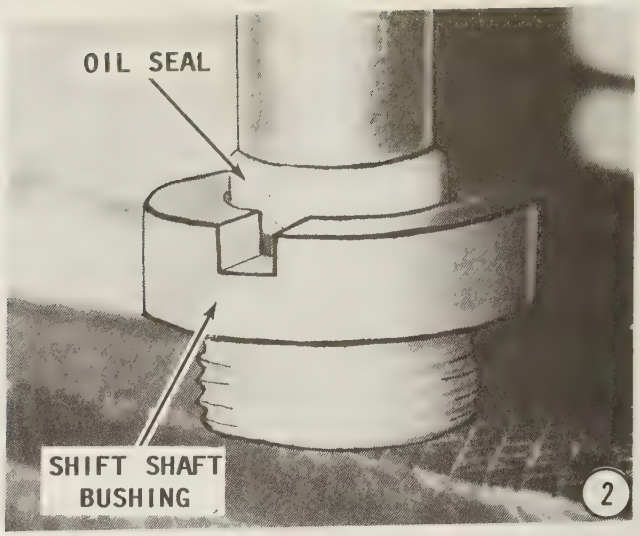


1 A

puller rod with the numbered side pointing toward the top of driveshaft bore. Screw mandrel tool P/N 91-38628 onto the end of the puller rod and center the roller bearing on the mandrel. Slide pilot washer tool P/N 91-36571 down the puller rod and center the pilot washer in the upper driveshaft bearing cavity. Install plate tool P/N C-91-29310 over the puller rod and down onto the lower unit housing. The plate tool should align with the water pump mounting studs. Thread the puller rod nut down the puller rod until it is flush against the plate. Hold the puller rod stationary with a wrench and turn the puller rod nut **CLOCKWISE**. Pull the driveshaft roller bearing **UP** into the bearing cavity until the bearing is flush against the shoulder in the lower unit housing.



1



2

Shift Shaft Assembling

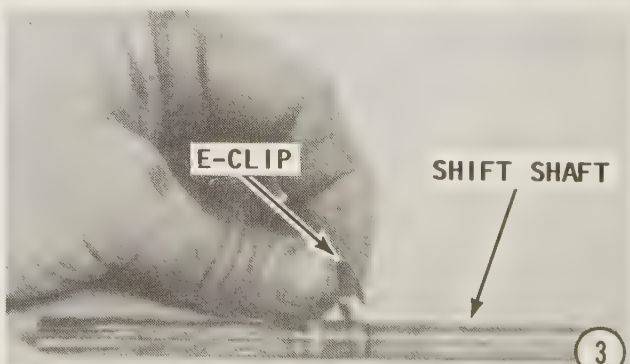
A new shift shaft bushing is sold as an assembly and will have the oil seals installed.

2- Place the shift shaft bushing on a press with the threaded side **DOWN**. Coat the metal surface of both oil seals with Loctite Type "A". Place the smaller diameter oil seal into the shift shaft bushing with the lip of the seal **TOWARD** the outside -- the top. Press the seal into place using a suitable size mandrel. Place the larger oil seal into the top of the shift shaft bushing with the lip of the seal **TOWARD** the outside -- the top. Press the seal into place using a suitable mandrel. Clean any excess Loctite from the seals and bushing. Install a **NEW O**-ring over the threads and against the shoulder of the bushing. Now, lubricate the seals and the **O**-ring with Multipurpose Lubricant, or equivalent.

3- Snap the **E**-clip into the groove in the shift shaft. The clip must be seated properly to prevent the shift rod from rising out of the shift cam in the lower unit.

Shift Shaft Installation

4- Place the cam into the forward portion of the lower unit between the cast



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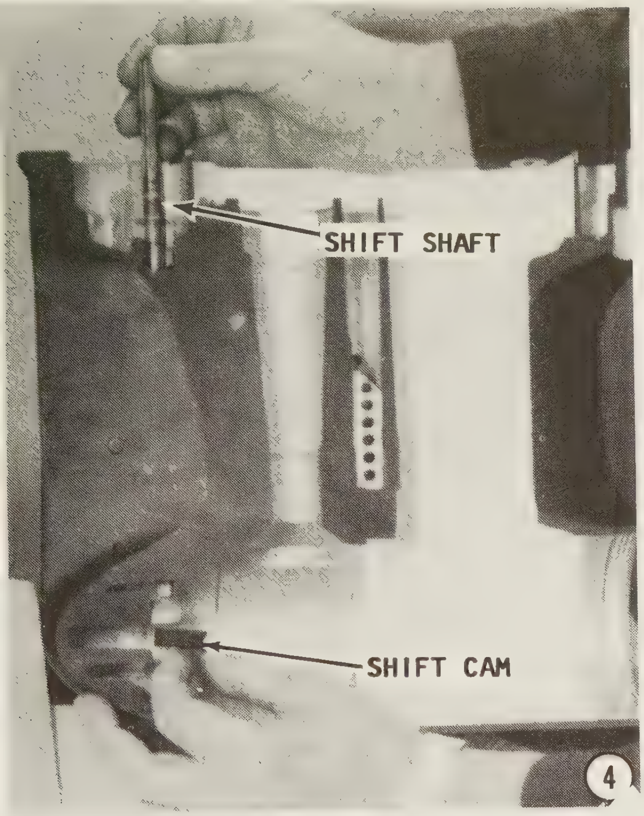
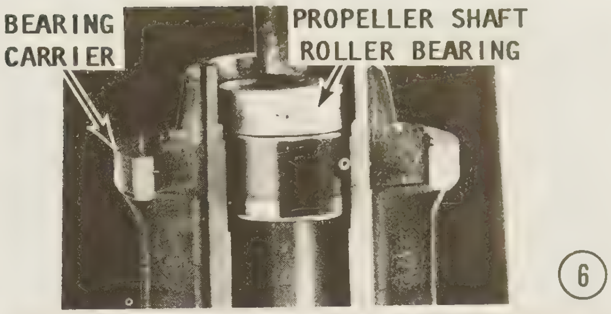
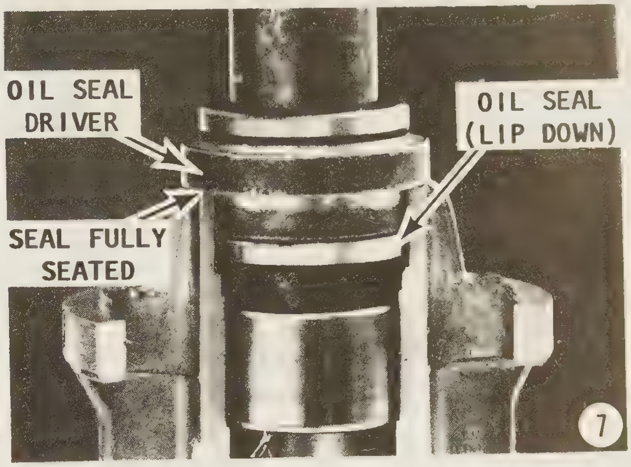


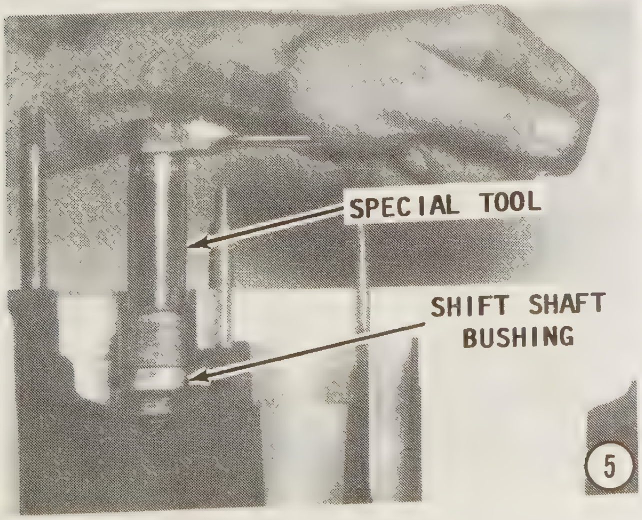




webbing. If the shift cam has numbers embossed on one side, then the side with the numbers **MUST** face **UP** after installation.

The ramps on the shift cam **MUST** be visible from the rear of the lower unit and the longer side, the reverse ramp, **MUST** be toward the left side, the fill screw hole side. Place the lower shift shaft, the short spline end, into the shift shaft cavity. Rotate the shift shaft to engage the splines into the splines of the shift cam.

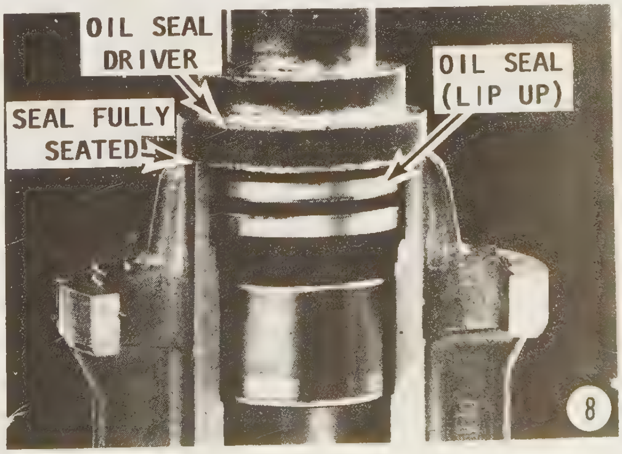
5- Slide the shift shaft bushing over the shift shaft and start the threads of the bushing into the lower unit. Obtain Shift Shaft Bushing Tool P/N C-91-23033. Use the tool to tighten the shift shaft bushing securely. **DO NOT** attempt to install the reverse lock cam at this time.

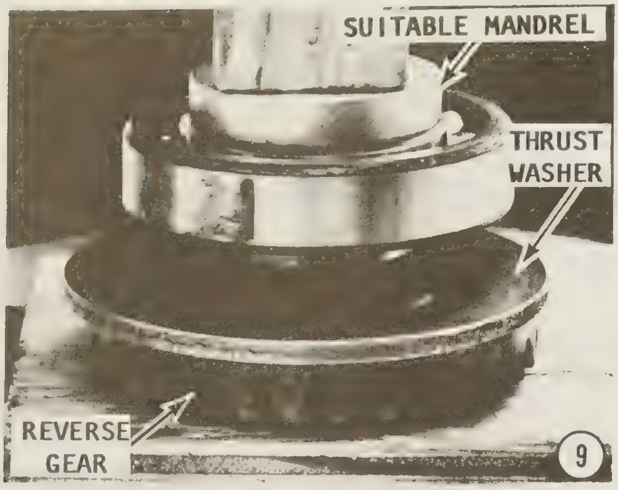


Bearing Carrier Assembling

6- Position the propeller shaft roller bearing into the aft end of the bearing carrier with the numbered side **TOWARD** the aft end. Press the roller bearing into the bearing carrier with a suitable mandrel.

7- Coat the outer diameter of the propeller shaft oil seals with Loctite Type "A". Obtain Oil Seal Driver C-91-31108. Place one seal on the longer shoulder side of the driver tool with the lip of the seal **AWAY** from the shoulder. Press the seal into the



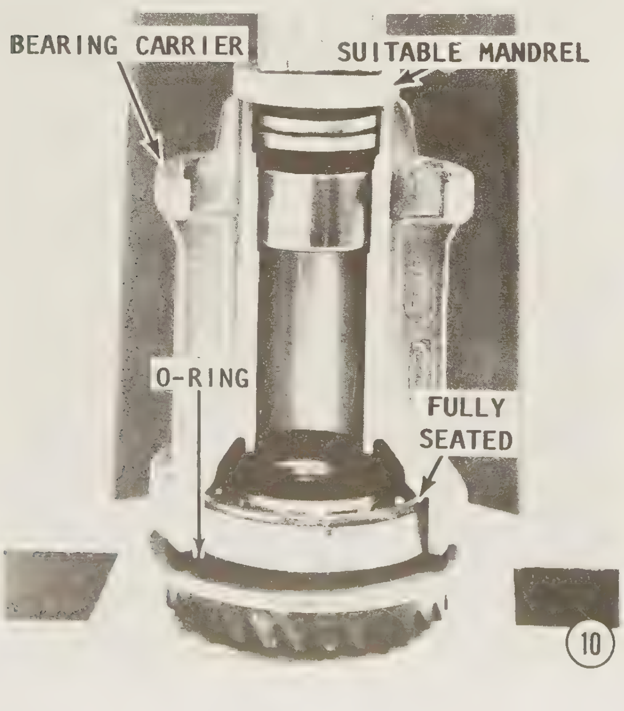


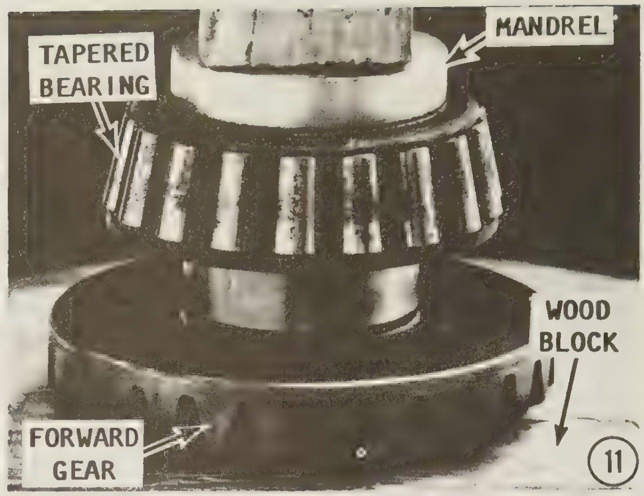
bearing carrier until the seal driver bottoms against the bearing carrier. Place the second seal on the short shoulder side of the seal driver with the lip of the seal **TOWARD** the shoulder.

8- Press the seal into the bearing carrier until the seal driver bottoms against the bearing carrier. Clean excess Loctite from the seals.

9- Position the reverse gear on a press with the gear teeth facing **DOWN.** Place the thrust washer over the gear. Place the ball bearing over the gear with the numbered side **UP.** Now, press the ball bearing onto the gear with a suitable mandrel.

10- Place the bearing carrier over the gear and bearing assembly. Press the bearing carrier onto the bearing. Place a **NEW** O-ring over the bearing carrier and position



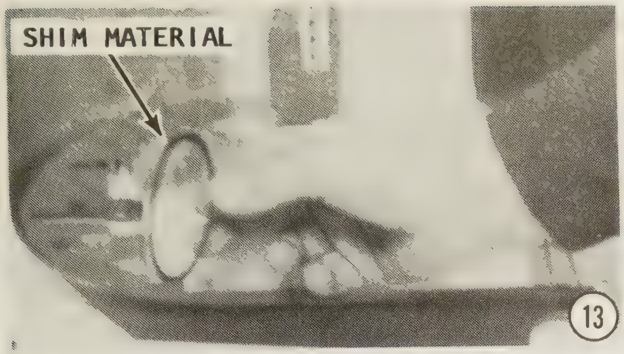


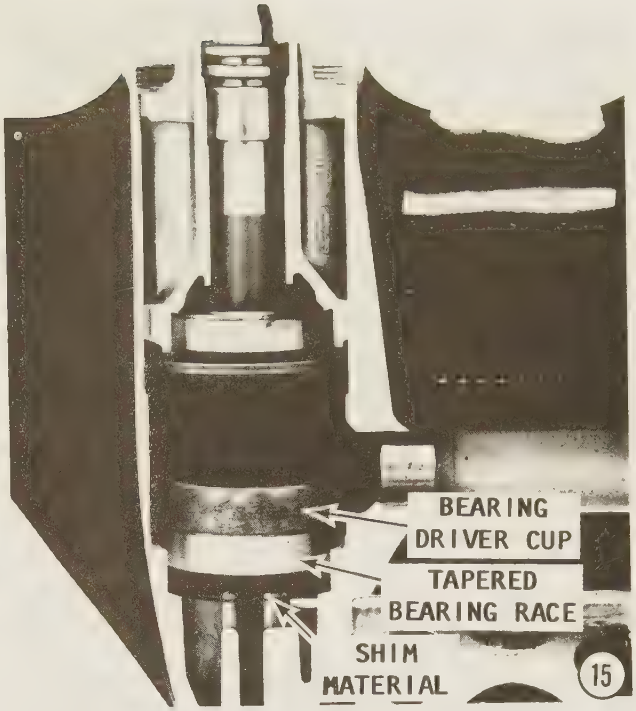
it between the bearing carrier and the thrust washer. Coat the O-ring and oil seals with Multipurpose Lubricant, or equivalent. Set the unit aside for installation later.

Forward Gear Assembling

11- Place the forward gear on a press with the gear teeth **DOWN.** Position the forward gear tapered bearing over the gear. Now, press the bearing onto the gear with a suitable mandrel until the bearing is firmly seated. Check for clearance (gap) between the inner bearing race and the shoulder of the gear. There should be **NO** clearance.

12- Position the roller bearing over the center bore of the forward gear with the numbered side of the bearing facing **UP.** Use a suitable mandrel and press the roller bearing into the gear until the bearing is seated against the shoulder.





CRITICAL WORDS

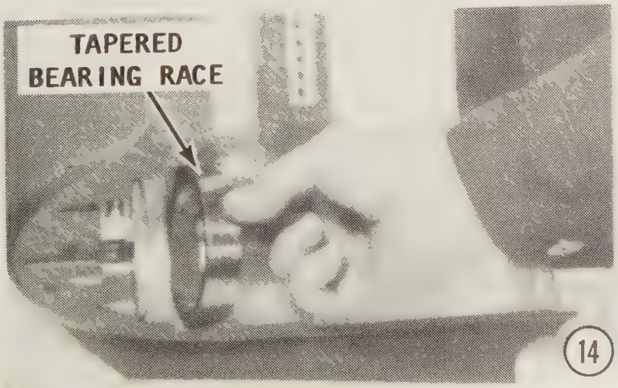
The bearing carrier is used as a pilot while installing the forward gear bearing cup in the next step. Therefore, the bearing carrier must have been assembled to include at least the propeller shaft roller bearing as outlined in Step 6.

Forward Bearing Race Installation

13- Place the same amount of shim material saved during disassembly into the lower unit. If the shim material was lost, or if a new lower unit is being used, begin with approximately 0.010" (.25mm) material. Coat the forward bearing race bore with Formula 50 oil.

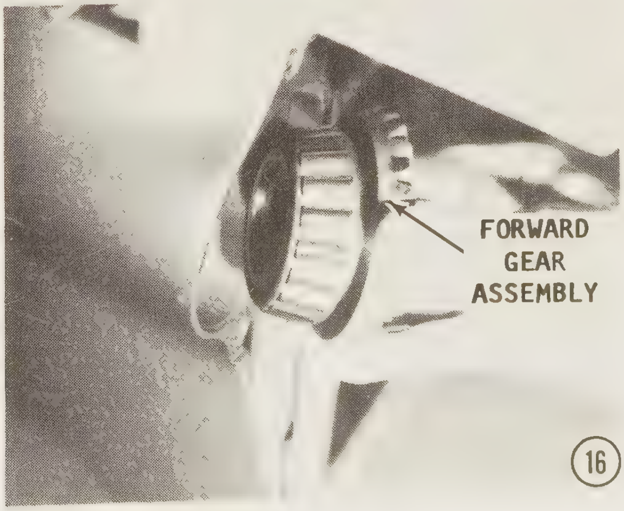
14- Position the tapered bearing race squarely over the bearing bore in the front portion of the lower unit. Obtain Bearing Drive Cup Tool P/N C-91-31361. Place the tool over the tapered bearing race.

15- Insert the propeller shaft into the hole in the center of the bearing cup. Lower the bearing carrier assembly down over the propeller shaft, and then lower it into the lower unit. The bearing carrier will serve as a pilot to ensure proper bearing race alignment. Now, use a mallet and drive the propeller shaft against the bearing driver cup until the tapered bearing race is seated against the shim material. Withdraw the propeller shaft and bearing carrier, then lift out the driver cup.



PLAN AHEAD

Obtain a suitable substance which can be used to indicate a wear pattern on the forward and pinion gears as they mesh. Machine dye may be used and if this material is not available, Desenex Foot Powder (obtainable at the local Drug Store/Pharmacy), or equivalent may be substituted. Desenex is a white powder available in an aerosol container. Before assembling either gear, apply a light film of the dye, Desenex, or equivalent, to the driven side of the gear. After the gears are assembled and rotated several times, they will be disassembled and the wear pattern can be examined. The substance will be removed from the gears prior to final assembly.



16- Position the forward gear assembly into the forward bearing race.

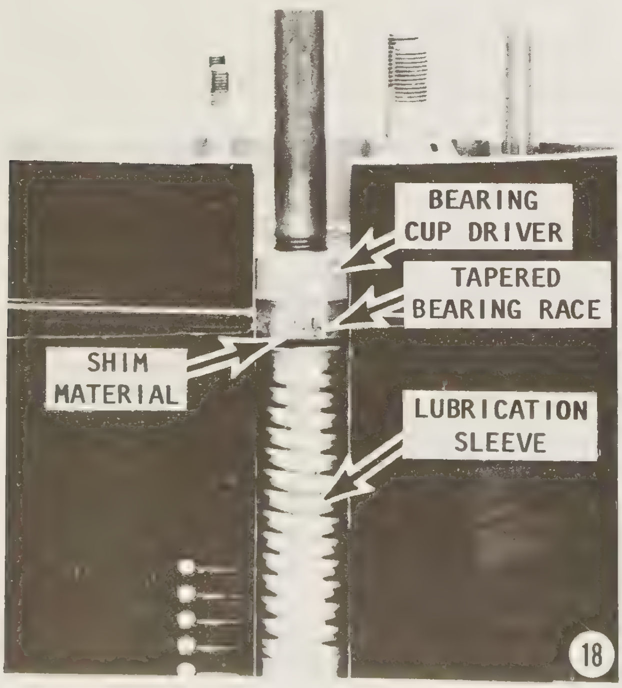
Driveshaft
Tapered Bearing

17- Position the driveshaft tapered bearing over the pinion gear end of the driveshaft. Use a suitable mandrel and press the bearing flush against the shoulder on the driveshaft.

Driveshaft Tapered
Bearing Race

18- Place the lubrication sleeve into the driveshaft cavity. **CHECK** to be sure the sleeve fits down into the cavity far enough to be below the shim surface. **DO NOT** use excessive force because the sleeve could be distorted.

Position the shim material saved during disassembling into the driveshaft cavity. Use a small amount of water resistant Multipurpose Lubricant to hold the shim material in place. Obtain Bearing Driver Cup P/N C-91-34379 and Bearing Removal and Installation Kit P/N C-91-31229A1. Now, using the cup and the bearing kit, drive the tapered bearing race into the lower unit cavity until the race is seated against the shim material.

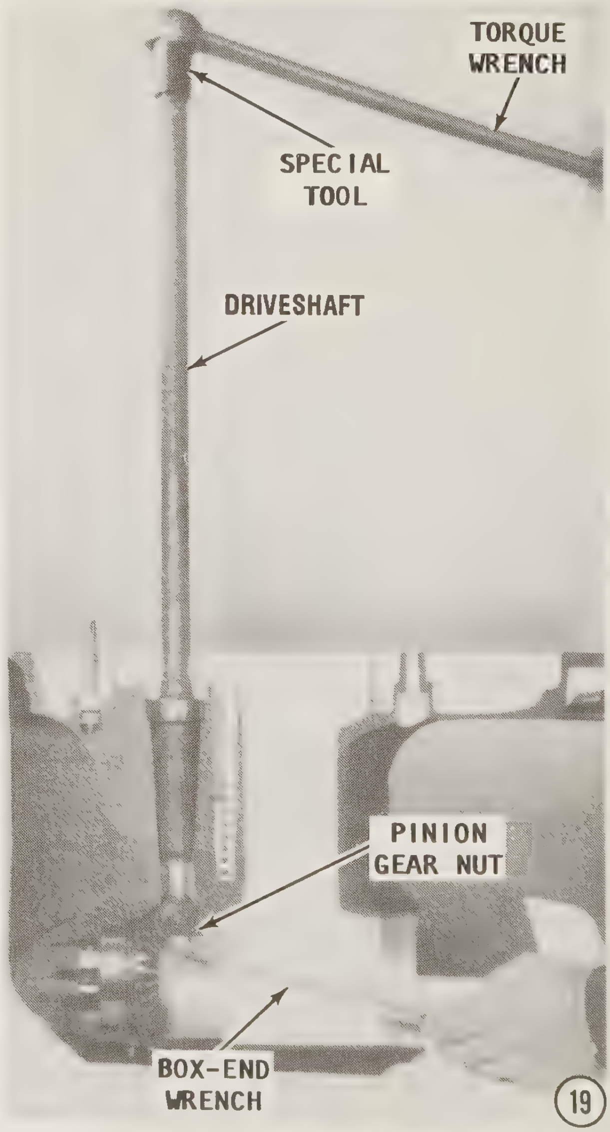


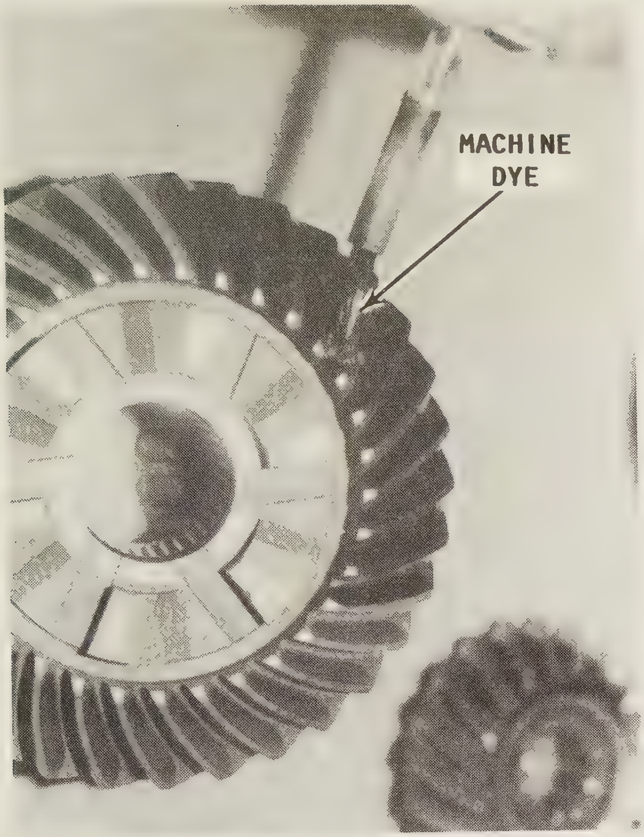
STOP!

Apply a thin coating of substance -- as explained in the "Plan Ahead" paragraph prior to Step 16 -- to the driven side of the pinion gear, before performing Step 19.

19- Position the pinion gear in the lower unit below the driveshaft cavity and with the teeth of the pinion gear indexed (meshed), with the teeth of the forward gear.

Hold the pinion gear in position and at the same time, insert the driveshaft into the





Applying machine dye to the gears in preparation to checking the gear wear pattern. Desenex® Foot Powder may also be used, as described in the "Plan Ahead" on Page 9-25.

driveshaft cavity. Now, rotate and insert the driveshaft until the driveshaft splines align and engage with the splines of the pinion gear. Continue to insert the driveshaft into the pinion gear until the tapered bearing is against the bearing race.

Start the pinion gear retainer nut. Hold the pinion gear retainer nut with a socket wrench. Pad the area where the socket wrench flex handle will contact the lower unit while the pinion nut is being tightened. Obtain Driveshaft Nut Wrench P/N C-91-56775. Place the wrench over the crankshaft end of the driveshaft. Use a torque wrench and socket to tighten the pinion nut to a torque value of 70-80 ft lbs (90-109Nm).

PINION GEAR DEPTH

NO WORK, BUT CRITICAL WORDS

No tools or physical work is involved in these words. However, they are **MOST** important toward the successful completion of the work.

Believe this -- the proper amount of pinion gear depth (pinion gear engagement with the forward gear), is critical for proper operation of the lower unit. Check the illustration numbered 20 and 21 on the next page. Notice the difference between the correct pinion gear depth drawing on the left and the incorrect drawing on the right.

Secure the services of an assistant, if possible, move slowly and deliberately through each step and follow the instructions carefully.

Checking Pinion Gear Depth

20- Grasp the driveshaft and pull **UP**. At the same time, check the pinion gear tooth engagement with the forward gear teeth to be sure contact is made the full length of the tooth. This check can be accomplished by using a flashlight and looking through the gear housing opening. Perhaps it would be helpful to have an assistant pull up on the driveshaft while the check is made.

Refer to the pinion gear and forward gear backlash adjustment following the next step.

21- Continue to hold the driveshaft with a strain in the **UP** direction. Reach into the bearing carrier cavity with your other hand and hook the forward gear with a couple fingers. Pull on the forward gear and rock it lightly back-and-forth. The amount of free "play" between the gear teeth is considered the gear backlash. Check the Specifications in the Appendix for the proper backlash allowed for the unit being serviced.

If the backlash appears to be correct, proceed directly to Step 41.

If the backlash is not within the Specification limits, proceed to make changes in the shim material according to the instructions outlined in the following steps.

Shim Material and Backlash

Adding or removing shim material will affect the forward gear and the reverse gear as follows:

Forward gear -- adding shim material **DECREASES** backlash.

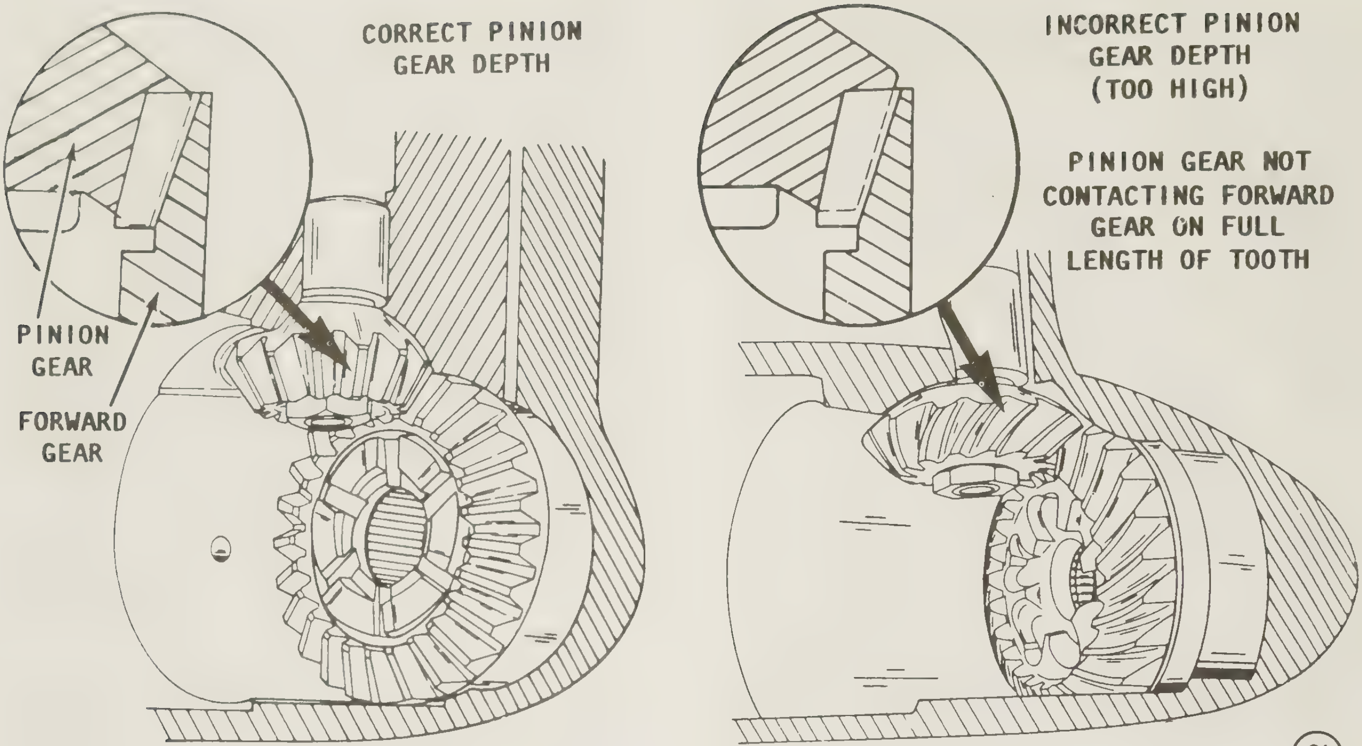
Forward gear -- removing shim material **INCREASES** backlash.

Reverse gear -- adding shim material **INCREASES** backlash.

Reverse gear -- removing shim material **DECREASES** backlash.

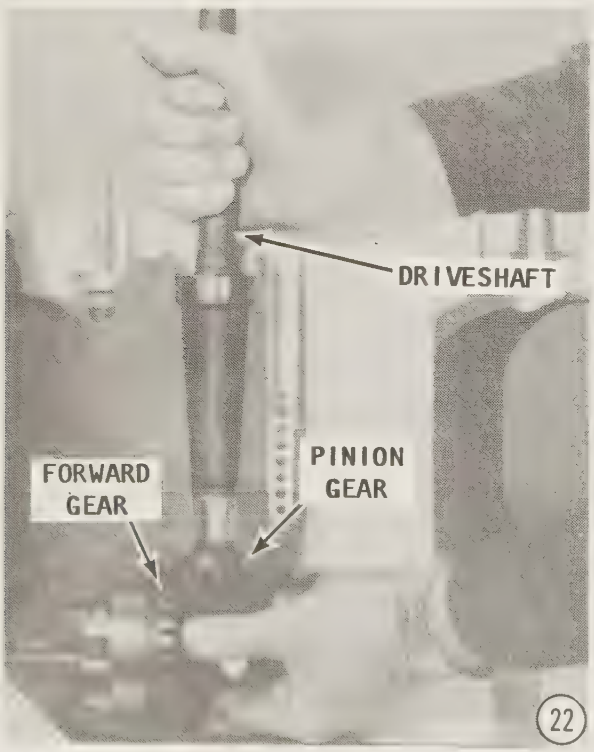
Forward Gear Backlash

22- Pull upward on the driveshaft. Hold the driveshaft in this position and check the



(21)

pinion gear tooth engagement with the forward gear teeth. Contact should be made the full length of the teeth. Now, place your other hand into the bearing carrier cavity with a couple fingers hooked in the forward gear. Pull on the forward gear and rock it lightly back-and-forth. The amount of free "play" between



(22)

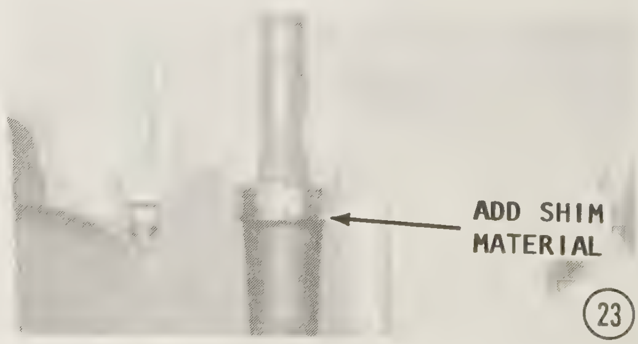
the gear teeth is considered the gear backlash. Check the Specifications in the Appendix for the proper backlash allowed for the unit being serviced.

If the backlash appears to be correct, proceed directly to Step 26.

If the backlash is not within the specification limits, proceed to make changes in the shim material, as follows.

PINION GEAR AND FORWARD GEAR BACKLASH ADJUSTMENT

The following procedures are to be performed for proper pinion gear and backlash adjustments. Because a variety of possibilities may develop as the work progresses,



(23)

step-by-step illustrations would only be confusing. Therefore, captioned illustrations are included with the instructions to provide an overall view of how the adjustments are to be made.

If the pinion gear depth or the forward gear backlash is incorrect, follow the shimming procedures under the heading for the specific condition discovered.

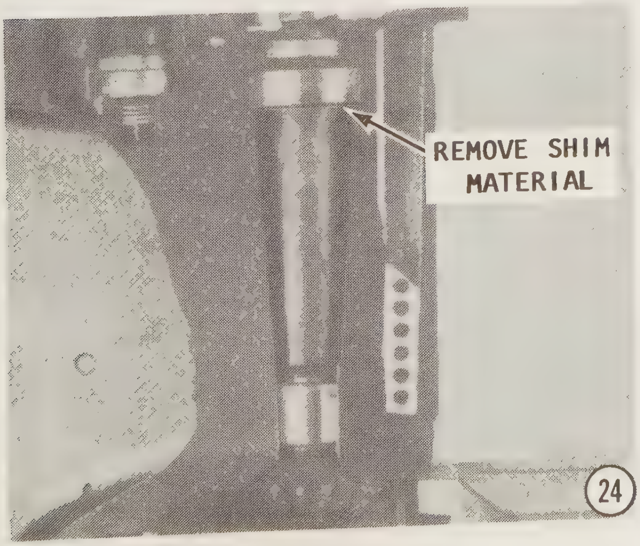
Pinion Gear Depth Too Deep but Backlash LESS than Specifications

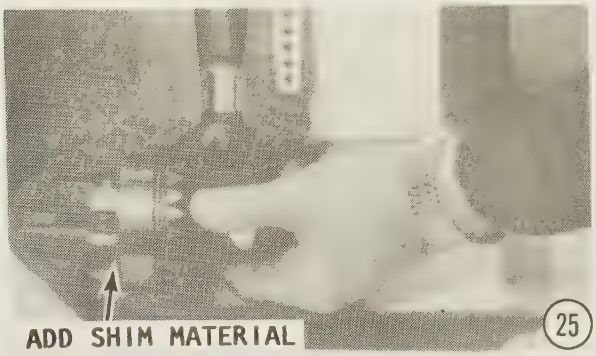
23- Remove the driveshaft, tapered bearing race if used, and the pinion gear. Add shim material to obtain the correct pinion gear depth. For each 0.001" (0.025 mm) of shim material added, the forward gear backlash will increase approximately 0.0015" (0.038 mm).

Assemble the parts and again check the pinion depth and forward gear backlash.

Pinion Gear Depth Too Shallow and Backlash LESS than Specifications

24- Remove the driveshaft, tapered bearing race, if one is used, and the pinion gear. Remove shim material to correct the pinion gear depth. Remove the forward gear and the forward gear bearing race. Remove an **EQUAL** amount of shim material from the forward gear, plus an additional amount to increase the forward gear backlash to the amount given in the Specifications. The forward gear backlash will increase approximately 0.0015" (0.038 mm) for each 0.001" (0.025 mm) of shim material





removed from in front of the forward gear bearing.

Assemble the parts and again check the pinion gear depth and the backlash.

Pinion Gear Depth Is Correct but Forward Gear Backlash is Excessive

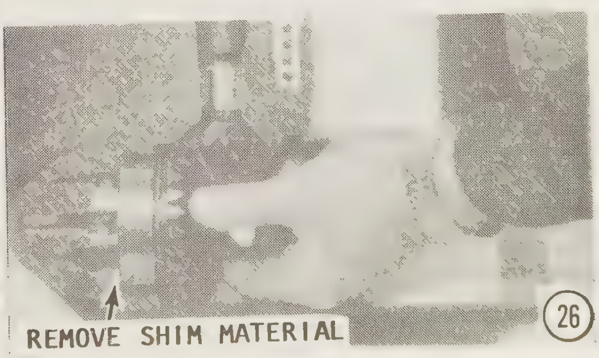
25- Remove the driveshaft and the pinion gear. Remove the forward gear and the forward bearing race. Add shim material to reduce the forward gear backlash. Adding 0.001" (0.025 mm) shim material will decrease the gear backlash by approximately 0.0015" (0.038 mm). Assemble the parts and again check the forward gear backlash.

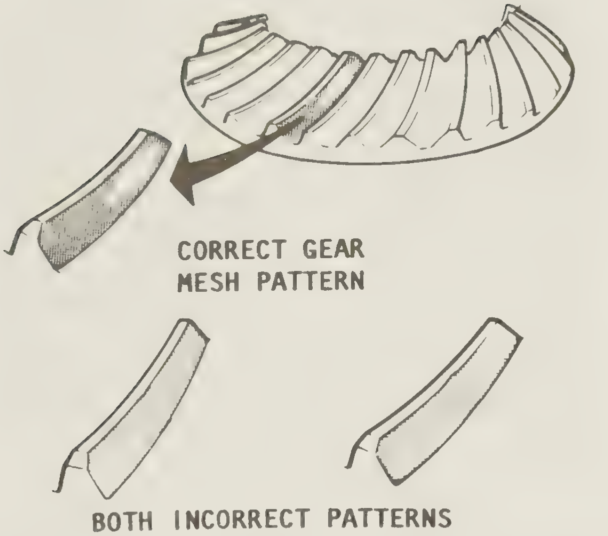
Pinion Gear Depth Is Correct but Backlash Less than Specifications

26- Remove the driveshaft and the pinion gear. Remove the forward gear and forward gear bearing race. Remove shim material to increase the gear backlash to specification. Removal of 0.001" (0.025 mm) shim material will increase the gear backlash approximately 0.0015" (0.038 mm).

Pinion Gear and Backlash Correct

Once the proper amount of backlash and the pinion gear depth is satisfactory, check the gear mesh pattern.





A normal gear wear pattern, as shown in the upper part of the illustration, will be centered on the tooth and will not extend over either end of the tooth.

27- With the unit still assembled, rotate the driveshaft **CLOCKWISE** approximately 6 to 8 complete revolutions.

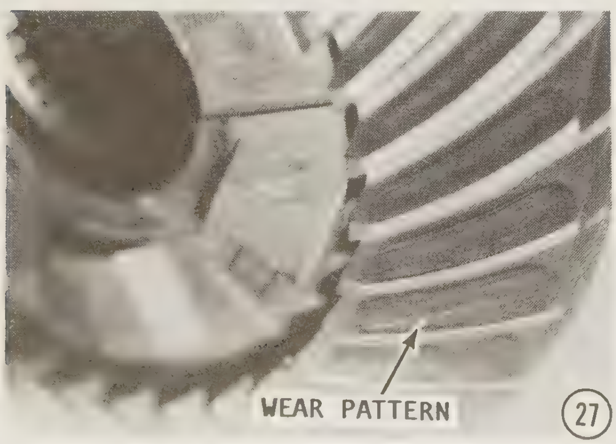
Now, disassemble the unit and compare the pattern made on the gear teeth with the accompanying illustrations. The pattern should almost be oval on the drive side and be positioned about halfway up the gear teeth.

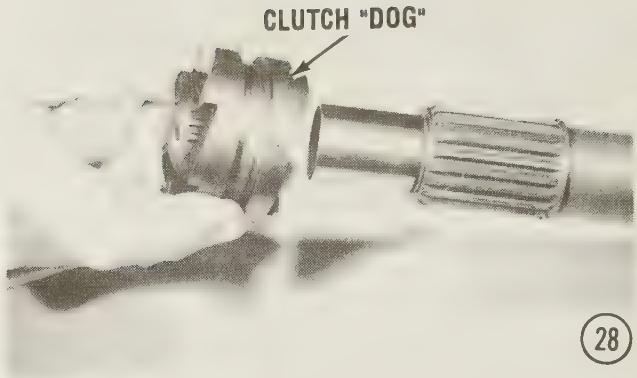
If the pattern appears to be satisfactory, clean the dye or powder from the gear teeth and assemble the unit one final time.

If the pattern does **NOT** appear to be satisfactory, add or remove shim material, as required. Adding or removing shim material will move the gear pattern towards or away from the center of the teeth.

Propeller Shaft Assembling

28- Align the hole through the clutch "dog" with the slot in the propeller shaft,



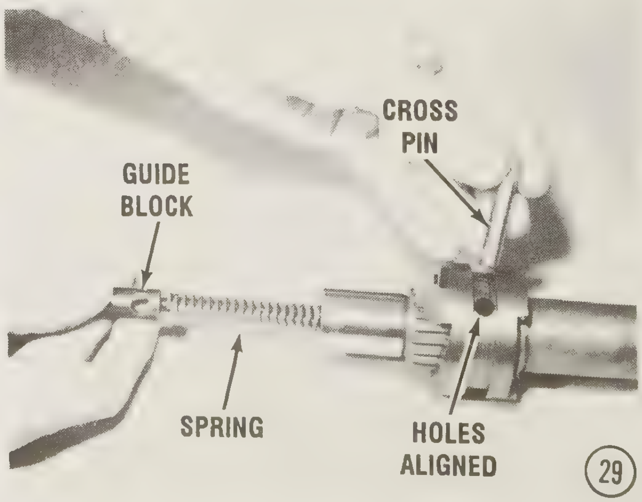


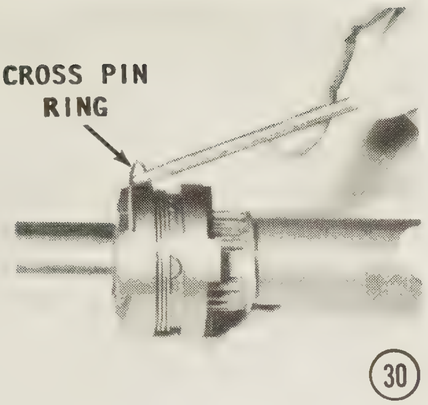
and then slide the "dog" onto the clutch with the "square" teeth facing the propeller end of the shaft. The teeth with the "slanted" ramps face **FORWARD.**

29- Insert the spring into the end of the propeller shaft. Insert the guide block, stepped end, into the front end of the propeller shaft with the cross-pin hole aligned with the cross-pin hole in the sliding clutch.

Temporarily insert the flat end of the cam follower into the front end of the propeller shaft. Position the cam follower against a solid object and push against the cam follower to compress the spring. Hold the propeller shaft in this position and at the same time, use a punch to align the guide block cross-pin opening with the sliding clutch cross-pin hole. Remove the punch and insert the cross-pin. Release pressure on the spring. Remove the cam follower.

30- Install the cross-pin ring over the sliding clutch. **TAKE CARE** not to over stretch the spring.





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31- Insert just a little water resistant Multipurpose Lubricant into the end of the propeller shaft. Insert the three very small steel balls. Set the propeller shaft aside ready for later installation.

GOOD WORDS

When handling the assembled propeller shaft, **TAKE CARE** to keep the forward end tilted slightly **UPWARD** to keep the small balls and other parts in place inside the shaft.

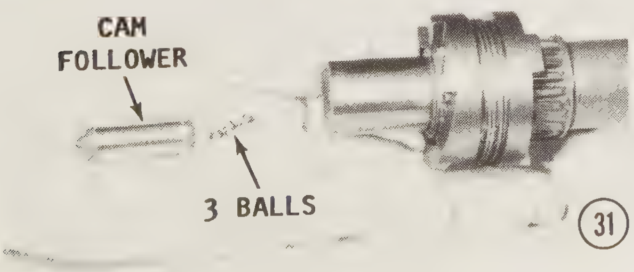
Bearing Carrier Installation

32- Insert the propeller shaft into the center of the forward gear assembly.

33- If the reverse gear backlash was correct before disassembly, as checked in Step 1, install the same amount of shim material retained during disassembly onto the shoulder in the lower unit to the rear of the reverse gear.

GOOD NEWS

The reverse gear backlash specification for units with Cam-Shift covered in this manual is 0.030-0.050" (0.762-1.27mm). This is a liberal 0.020" (0.51mm) "play". If the backlash is not within the 0.020" specification, the unit **MUST** be disassembled; shim material added or removed; and the unit assembled again. The backlash will change approximately 0.0015"



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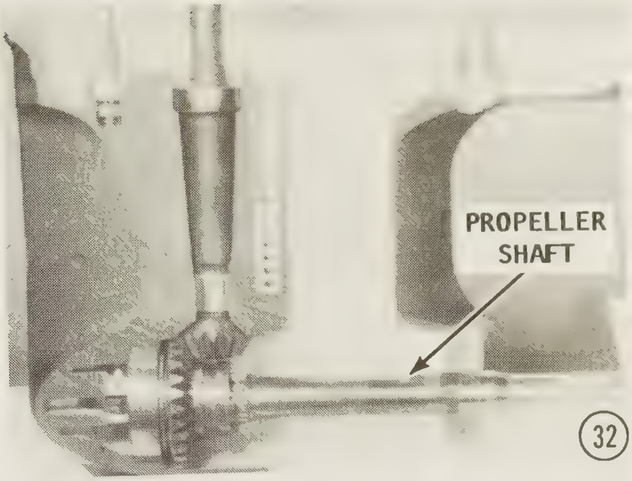

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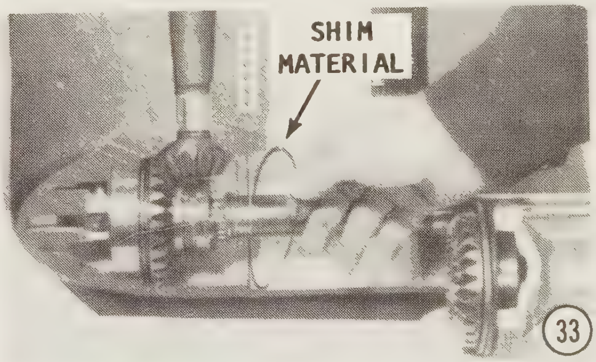
(0.038mm) for each 0.001" (0.025mm) change in shim thickness. Adding shim material will increase the backlash; removing shim material will decrease the backlash.

34- Install a **NEW O**-ring into the groove between the bearing carrier and the thrust washer. Coat the **O**-ring and propeller shaft oil seals with Multipurpose Lubricant. Coat the outside surfaces of the bearing carrier where the carrier contacts the lower unit with Perfect Seal. **PREVENT** the Perfect Seal from entering the bearings. Slide the bearing carrier into the lower unit. **TAKE CARE** not to damage the propeller shaft oil seals. Push the bearing carrier into the



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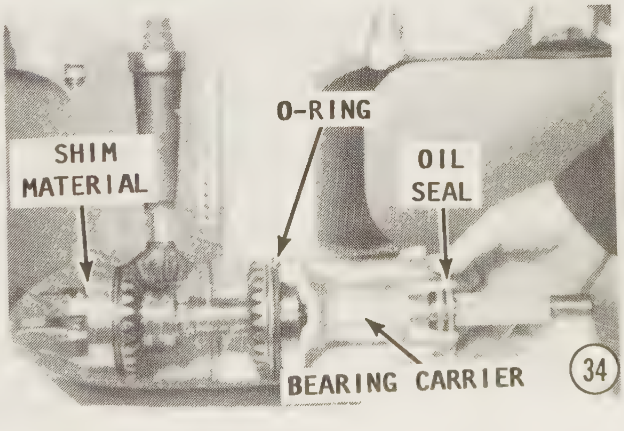

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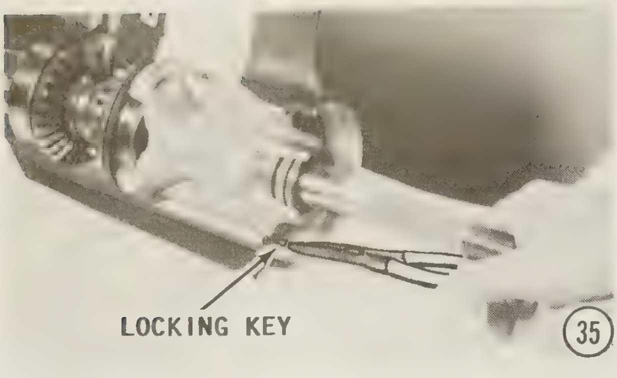


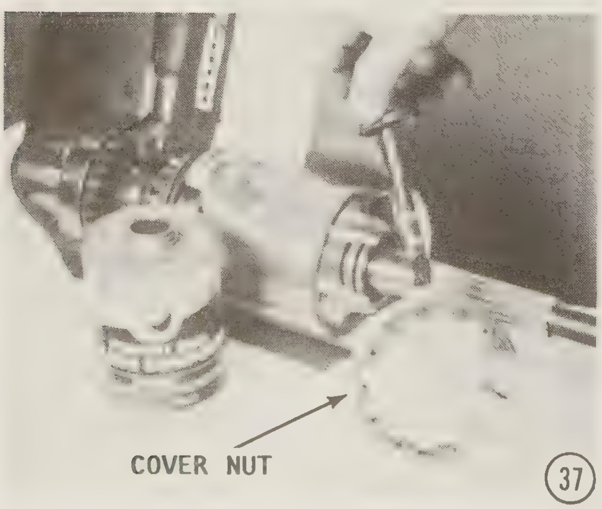
lower unit and at the same time slowly rotate the driveshaft to allow the pinion gear teeth to engage with the reverse gear teeth.

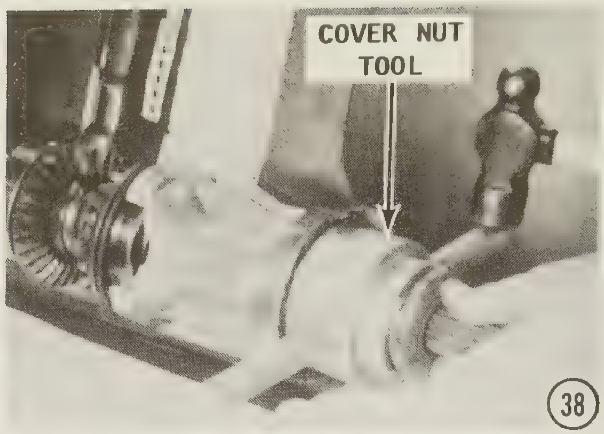
35- Align the keyway in the bearing carrier with the keyway in the lower unit, and then insert the locking key.

36- Slide a **NEW** tab washer over the bearing carrier with the **"V"** portion opposite the keyway.

37- Coat the threads of a new plastic bearing carrier cover nut with Perfect Seal. Insert the cover nut into the bearing carrier with the word **OFF** and the arrow visible.

38- Start the cover nut a few turns **BY HAND** as a precaution against cross-threading. Obtain Gear Housing tool P/N C-91-91947.



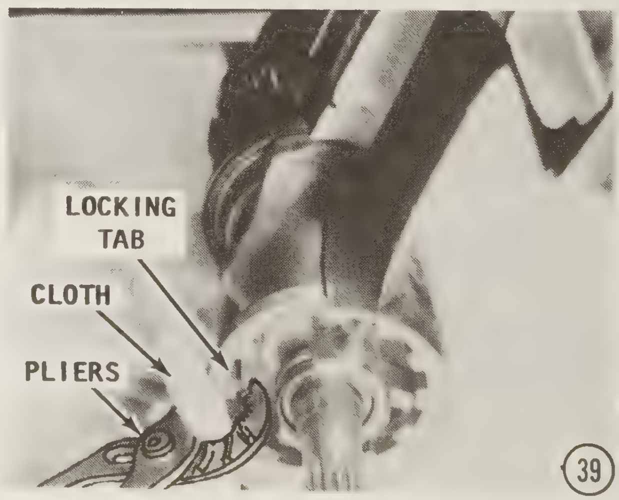


Tighten the cover nut with the tool to a torque value of 100 ft lbs (136Nm).

39- Use a pair of water pump pliers to perform this step and pad the lower jaw of the pliers to protect the outside finish of the lower unit. Bend one of the locking tabs down into a cutout in the cover nut. The tabs are arranged in such a manner that one, and maybe more, will align with the cutouts in the nut.

Reverse Gear Backlash

40- Shift the lower unit into reverse gear. Rotate the propeller shaft **COUNTERCLOCKWISE** to take-up any free-play between the reverse gear and the clutch dogs. Shift into neutral gear and rotate the propeller shaft only 1/8" (3.17 mm) **COUNTERCLOCKWISE.** Now, attempt to shift into reverse gear. The attempt should **FAIL.** If the attempt is successful and it is possible to shift into reverse gear, repeat this step. Hold pressure on the lower shift shaft toward the reverse gear and at the same time,

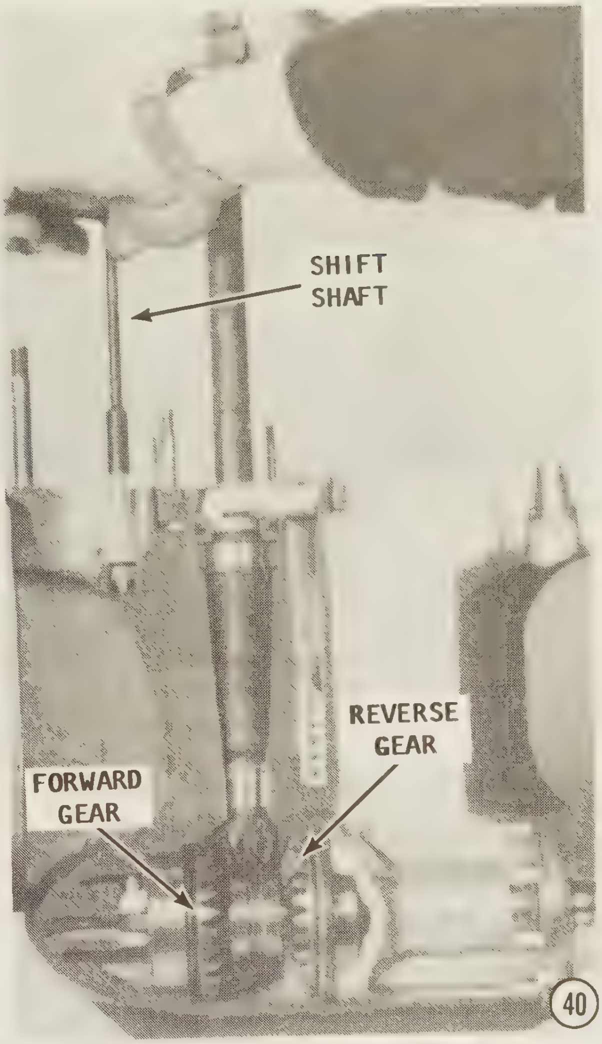


push down on the driveshaft and have an assistant pull outward on the propeller shaft, and at the same time rock the shaft lightly left-and-right.

The amount of free-play felt is the reverse gear backlash. The free-play should be 0.040-0.060" (1.016-1.524mm) for all Cam-Shift Type I units covered in this manual.

If the reverse gear backlash is incorrect, change the amount of shim material behind the reverse gear according to Step 33.

41- Slide the bottom driveshaft seal onto the upper part of the driveshaft with the splined end of the seal facing **UPWARD**. Install the top driveshaft seal onto the driveshaft with the smaller outside diameter of the seal facing **UP.**



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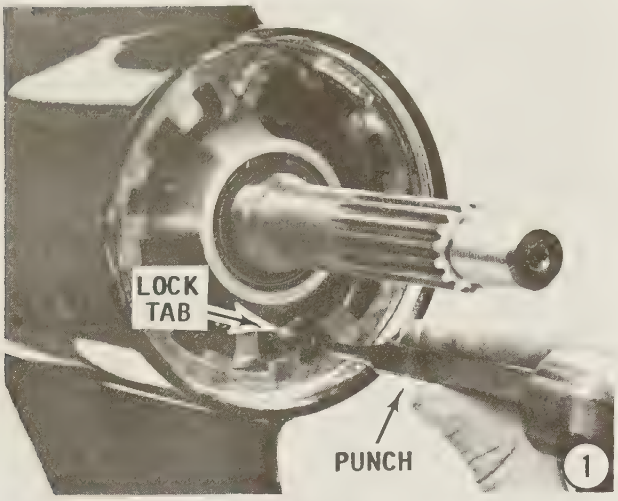
SPECIAL GOOD WORDS

The cam-shift lower unit is now ready for installation of the water pump, including the base and shimming, if required.

Proceed directly to Section 9-7, Water Pump Installation, beginning on Page 9-64.

After the water pump has been assembled, procedures to install the lower unit are presented in Section 9-9, beginning on Page 9-70.

Once the lower unit is secured, the outboard unit should be mounted in a test tank, the boat moved to a body of water, and the completed work checked.



9-6 SERVICING E-Z SHIFT LOWER UNIT

SPECIAL WORDS

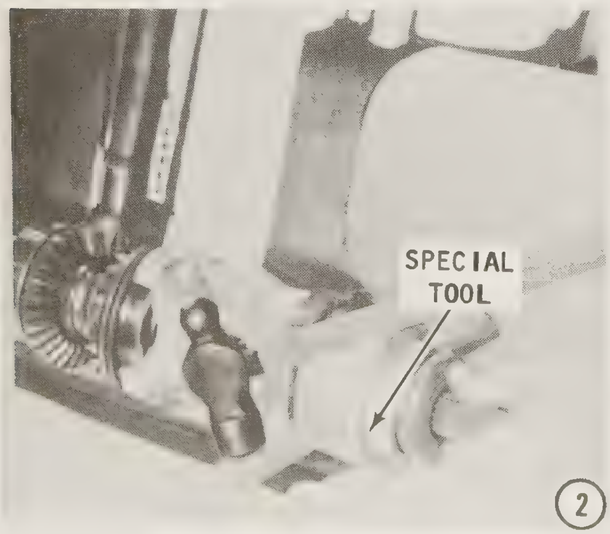
The differences between an E-Z shift and a Cam Shift lower unit are explained in Section 9-1, first page. A simple test is also explained to verify which unit is to be serviced. Check and be sure the correct procedures are being followed.

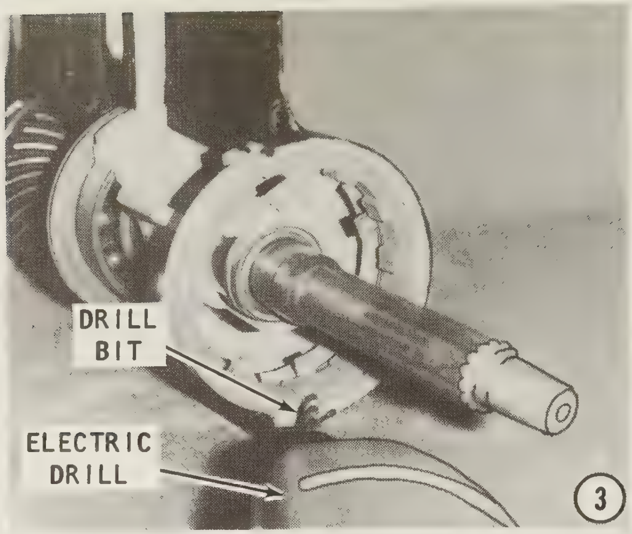
The following procedures pickup the work for an E-Z shift after the lower unit has been separated from the driveshaft housing, as outlined in Section 9-3, and the water pump has been removed per Section 9-4.

Bearing Carrier Removal

1- Bend the lock tab away from the cover nut of the bearing carrier recess with a punch. Some models may not have the lock tab.

2- Place the smaller diameter end of Gear Housing Cover Tool C-91-53126 into





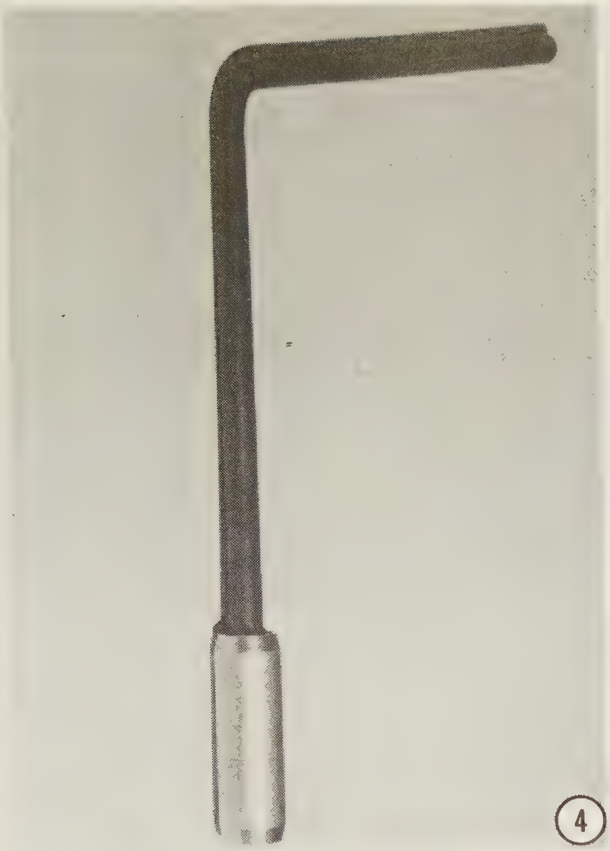
the cover nut. Slide the thrust hub over the end of the propeller shaft and down into the cover tool. The thrust hub will tend to keep the cover tool square against the cover nut. Strike the handle of the cover tool sharp blows with a mallet to turn the cover nut **COUNTERCLOCKWISE.**

As the cover nut loosens, continue to remove it with the cover nut tool. If the cover nut refuses to budge, it may be necessary to carefully apply heat to the lower unit around the outside of the nut.

3- If the nut still refuses to loosen, a last resort is to drill the nut, as shown.

4- Double check to be sure the E-Z shift is in **NEUTRAL** gear before proceeding. A simple check is to rotate the propeller shaft back-and-forth while observing the driveshaft. The driveshaft should **NOT** rotate in either direction. If the unit needs to be

"Frozen" bearing carrier nut after being sacrificed and drilled out, thus saving more expensive parts.



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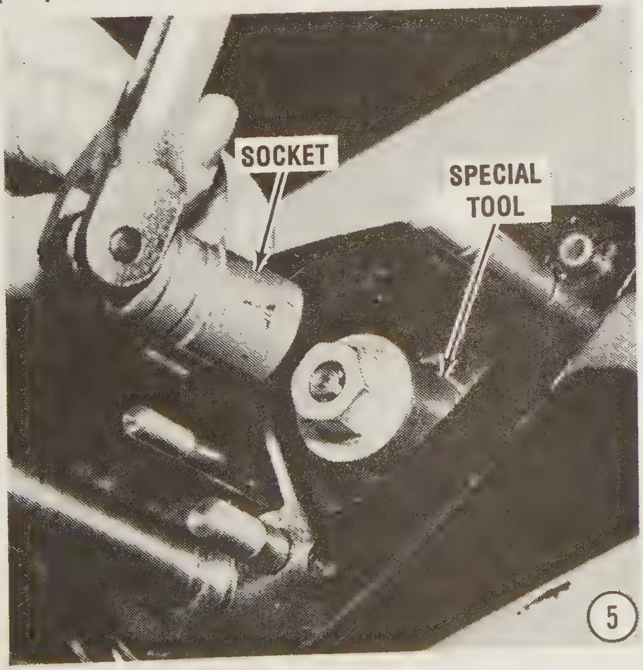
shifted into neutral, take care not to scar the shift shaft while rotating it. A special tool may be made from the upper portion of a shift shaft, bend and cut, as shown. If this tool cannot be made, wrap a piece of soft material around the splines, aluminum will do, and then use a pair of pliers.

If the unit is not in neutral gear, the propeller shaft cannot be withdrawn from



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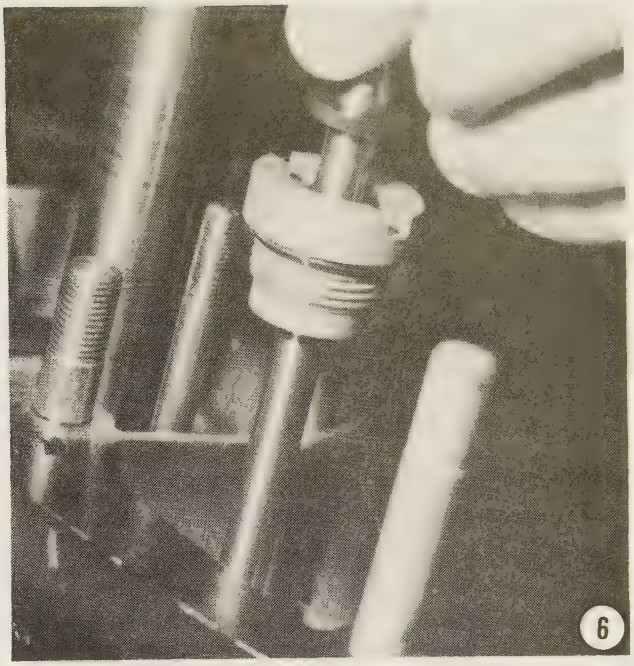

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the lower unit housing until the cam in the pocket is returned to the neutral position. This is not an easy task to do later.

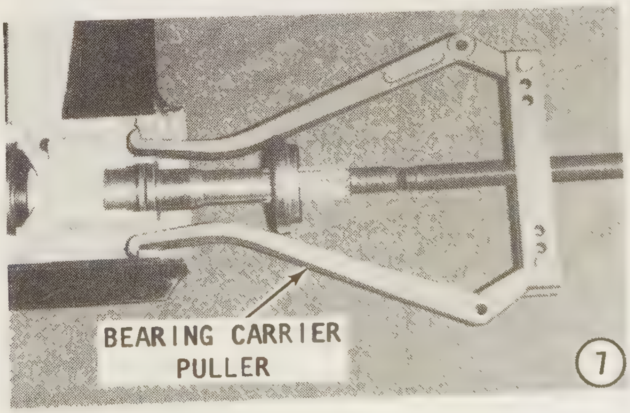
Therefore, let it be said again: the unit must be in **NEUTRAL.**

5- Obtain shift shaft bushing removal tool C-91-31107. Use the special tool and the proper size socket to unthread the bushing. If the special tool is not available, a blunt punch indexed in one of the slots near the outer edge and a hammer may be used to unthread the bushing. Work carefully, using sharp, short, quick blows with the hammer.

DO NOT remove the bushing from the shift shaft, at this time.

CAUTION

Again check to be sure the unit is in **NEUTRAL.** The unit in neutral will save much time and frustration when it comes time to withdraw the propeller shaft.



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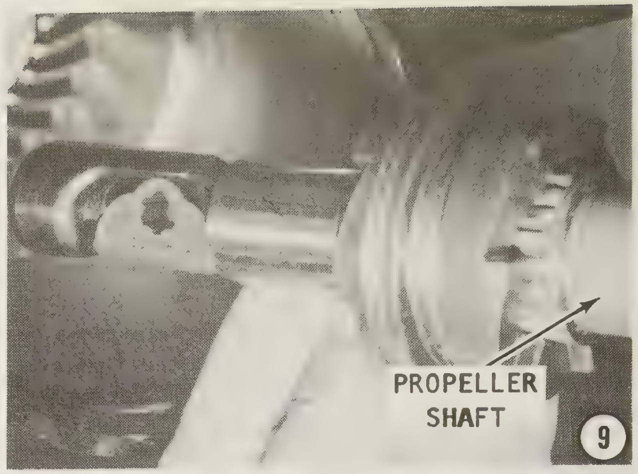
6- After you are positive the unit is in **NEUTRAL,** withdraw the shift shaft and the bushing from the lower unit.

7- Obtain a bearing carrier puller or long jaw puller C-91-46086A1. Hook the jaws of the puller onto the back side of the bearing carrier. Tighten the thru bolt against the outer end of the propeller shaft. As the bolt is tightened, the bearing carrier will begin to move.

8- After the carrier is loose, pull it free of the lower unit housing, but leave the propeller shaft in place, at this time. **TAKE CARE** not to lose the alignment key from the bearing carrier. The reverse gear will come out with the carrier.

9- Grasp the propeller shaft and attempt to withdraw it straight out of the lower unit housing. If the unit has been in neutral, as instructed, the shaft will come free of the lower unit housing. If the unit was not in neutral, the shaft will not come free. **DO NOT** jerk or attempt to force the propeller shaft free. Any forcing will only damage the shift mechanism and the shaft will still not come free.

If the unit was not in neutral, and the propeller shaft will not move outward, push the shaft back into place against the forward gear. Use a flashlight and look down into the lower unit and observe the location of the shift cam. If the splined hole in the shift cam is visible, install the shift shaft back into place. Now, rotate the shift shaft to the **NEUTRAL** position. Carefully, withdraw the propeller shaft.

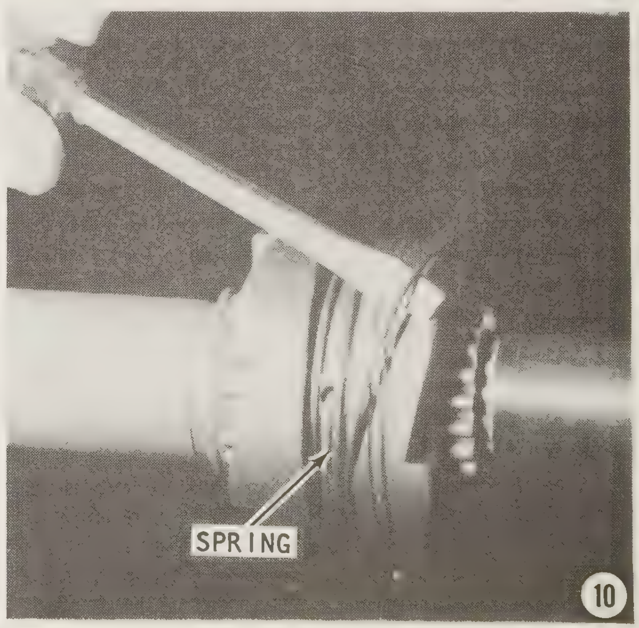


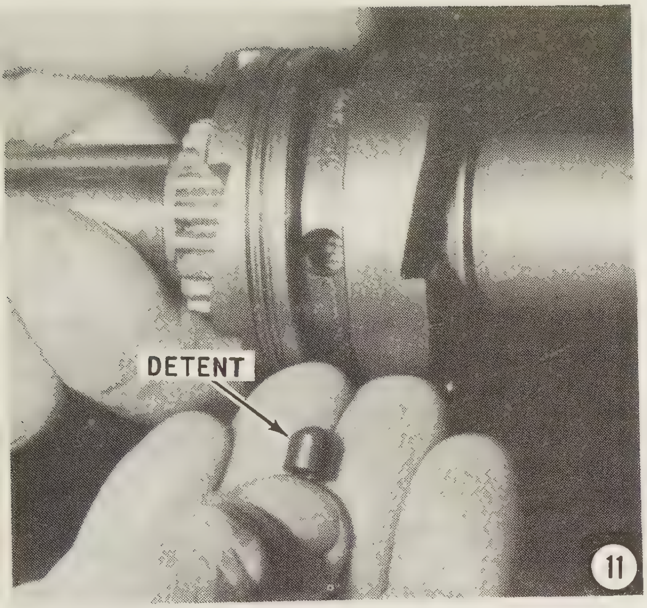
If the splined hole in the shift cam was not visible, as described in the previous paragraph, slide the bearing carrier part way back into place to support the propeller shaft. Place the lower unit housing on the deck with the port side of the housing facing upward. Now, rock the housing on the deck and from time to time attempt to withdraw the propeller shaft. What this maneuver will accomplish is to slide the cam back into the neutral position and thus enable the propeller shaft to be withdrawn.

As the propeller shaft is withdrawn the shift clutch, shift cam, cam follower, actuator rod and associated parts will come out with the shaft. Set these loose parts aside for cleaning.

Propeller Shaft Disassembling

10- Slide a thin screwdriver or awl under the end of one cross pin retainer spring, as shown. Rotate the propeller shaft and the

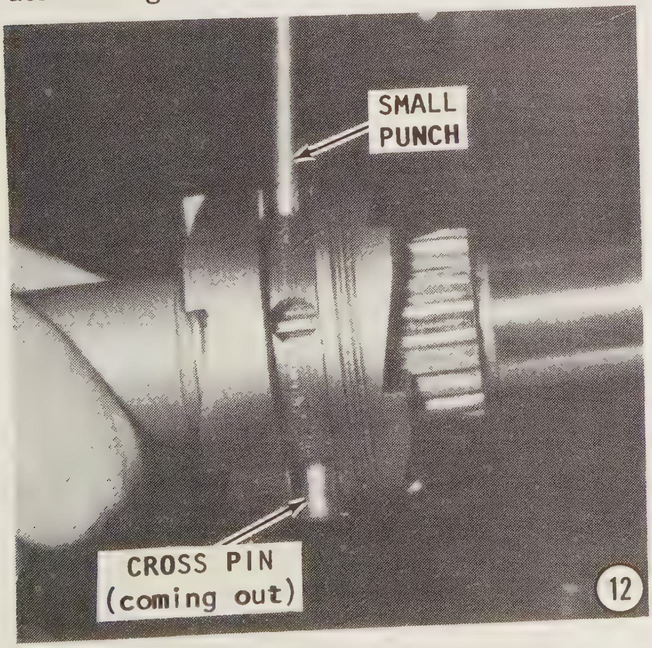




spring will come free of the sliding clutch. The two springs are identical, but installed on the clutch in opposite directions. Therefore, insert the screwdriver or awl under the second spring and rotate the propeller shaft in the opposite direction. The second spring will come free. **TAKE CARE** not to stretch the springs any more than necessary.

11- After the two springs have been removed as described in Step 10, the two detents will fall free.

12- Obtain a suitable small size punch and push the cross pin free of the sliding clutch. A hammer is not necessary because the pin is only a "snug" fit in the clutch. Notice the two flat sides on the pin. These flat sides will be most important during assembling.



13- Pull the cam follower and clutch actuator **STRAIGHT** off the propeller shaft end. Do not force the cam follower up or down or from side to side as follower is removed from the shaft.

14- The parts of the actuator rod assembly, as shown in the accompanying illustration, will all come free. Be sure to **SAVE** the shim washer and note how it was placed on top of which spring, as an aid to assembling.

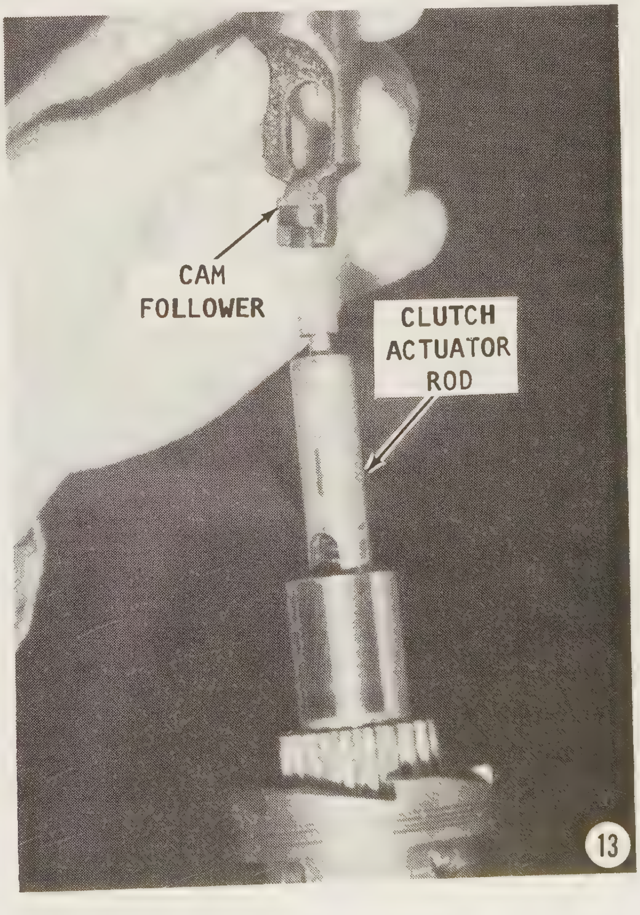
15- Pull the sliding clutch free of the propeller shaft.

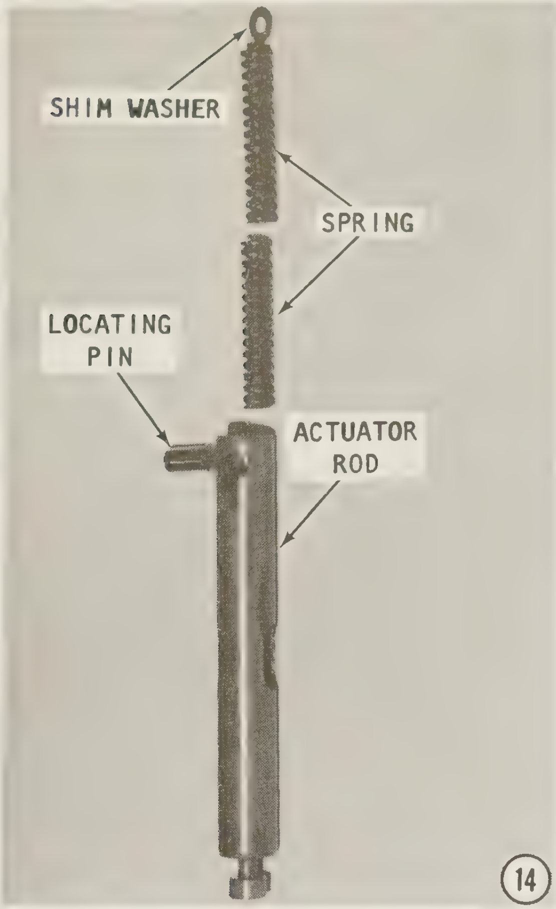
Driveshaft and Bearing Removal

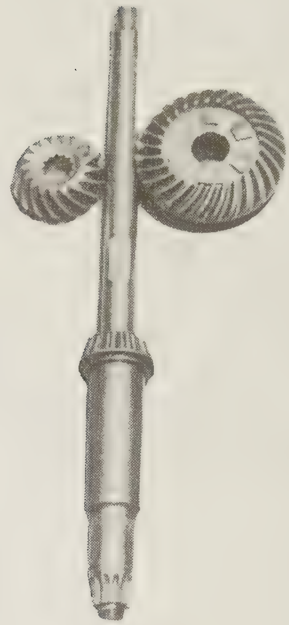
SPECIAL WORDS

The E-Z shift cam follower and the plunger arrangement differs between Model 225hp and the Model 275hp. The Model 225hp has a spool assembly and all parts are purchased as a complete unit, as indicated on the exploded drawing on Page 9-45. Therefore, if one part is defective only a complete assembly can be purchased. The Model 275hp lower unit has a unique arrangement of individual parts, as indicated on the exploded drawing on Page 9-47.

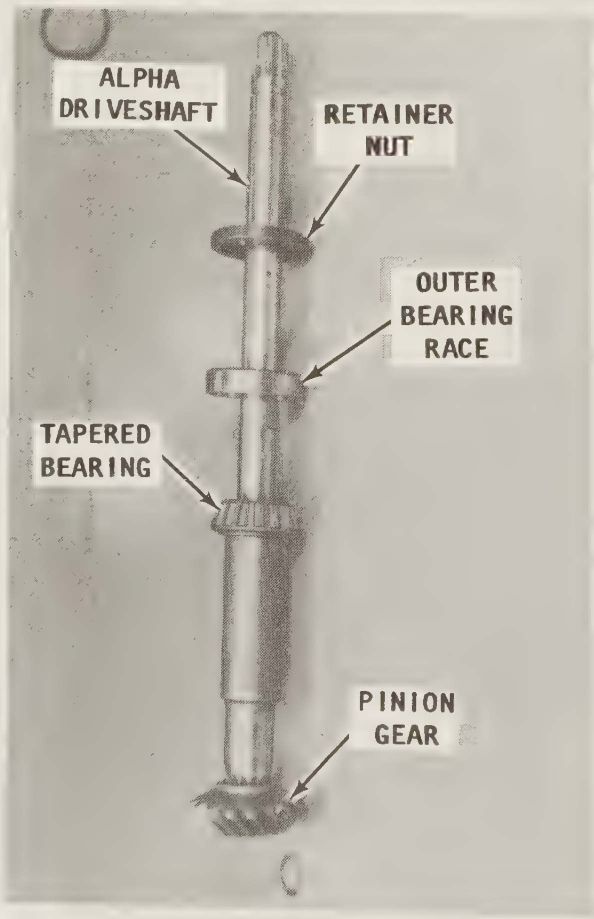
These differences are clearly identified in the text.



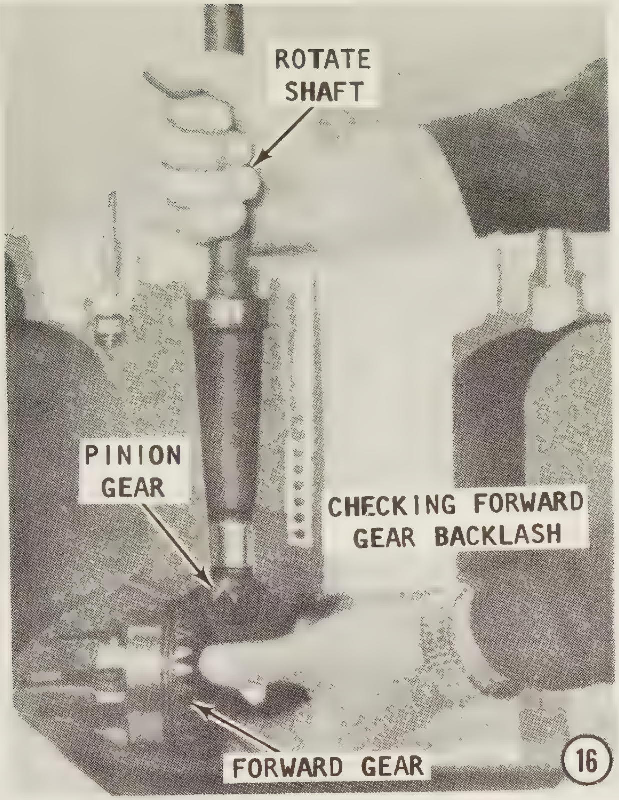




Close view of the driveshaft, pinion gear, and forward gear to illustrate the bevel and gear pattern.



Driveshaft with associated parts arranged in the order of installation.



16- Clamp the skeg upright in a vise equipped with soft jaws. **BEFORE** disassembling the unit, check the forward gear to pinion gear backlash. The amount of backlash is easily determined in the following manner.

Begin by pulling **UP** on the driveshaft with one and at the same time rock the forward gear back-and-forth with the other hand. The amount of movement felt is the backlash -- commonly expressed as simply "play" between the gears. Check the Specifications in the Appendix for the allowable amount of backlash recommended for the unit being serviced.

SPECIAL SHIM MATERIAL WORDS

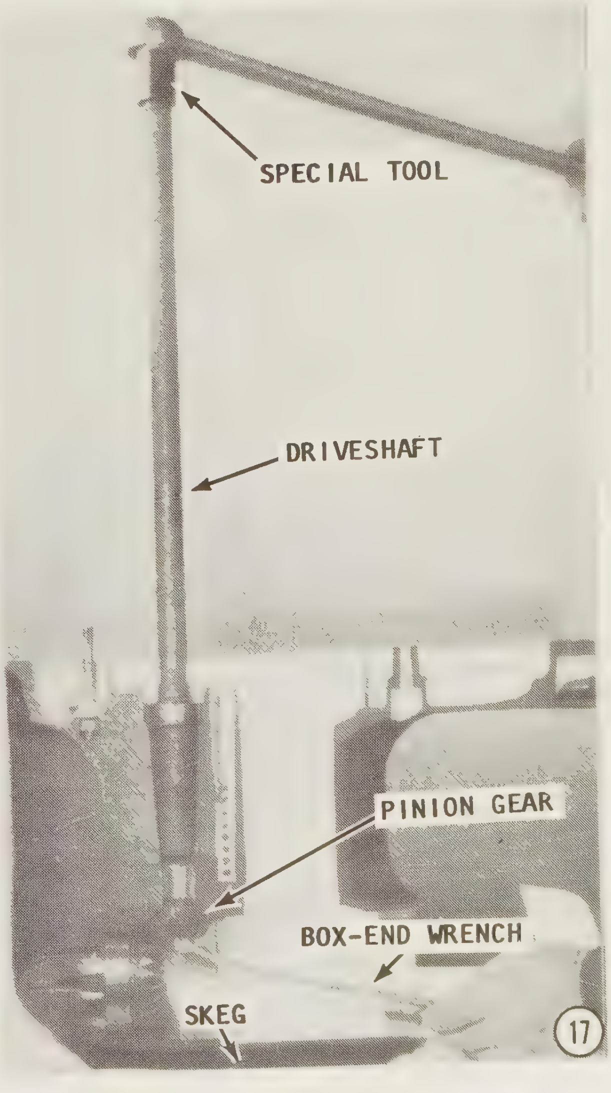
Make an earnest effort to keep track of the shim material removed at any location. Such a record will prove most valuable during the assembly work.

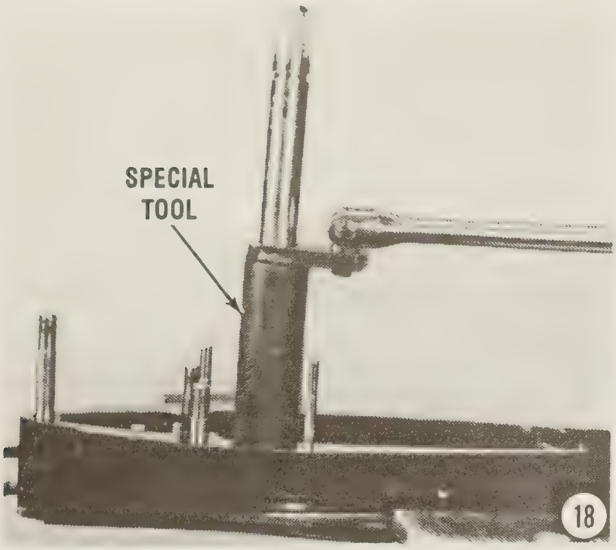
SEAL ADVICE

Good shop practice dictates new **O**-rings and oil seals be installed, regardless of their apparant satisfactory condition, any time the component is disassembled and these items are removed. As a general rule **O**-rings and seals should not be used a second time -- unless in an emergency situation and replacements are not available.

17- Leave the lower unit clamped in the vise. Obtain special wrench C-91-56775, (or C-91-34377A1 for coarse splines) and a breaker bar to work the driveshaft. Obtain special pinion nut holding tool C-91-61067A1. If the pinion nut holding tool is not available, a substitute can be made from a proper size box-end wrench for the nut. Grind the wrench down on both sides until it will clear the pinion teeth. Hold the nut with the modified box-end wrench, as shown and at the same time, rotate the driveshaft counterclockwise with the special tool and breaker bar until the nut is released from the driveshaft. Remove the pinion gear.

18- Obtain bearing retainer nut special tool C-91-43506. Slide the special tool down the driveshaft until the tool is indexed



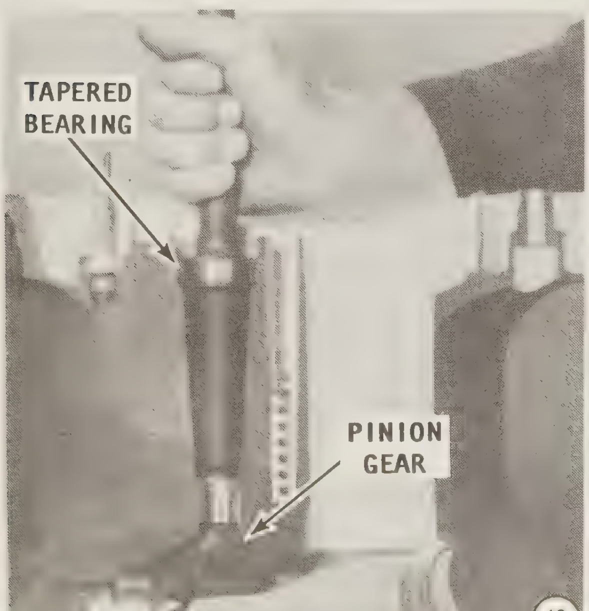


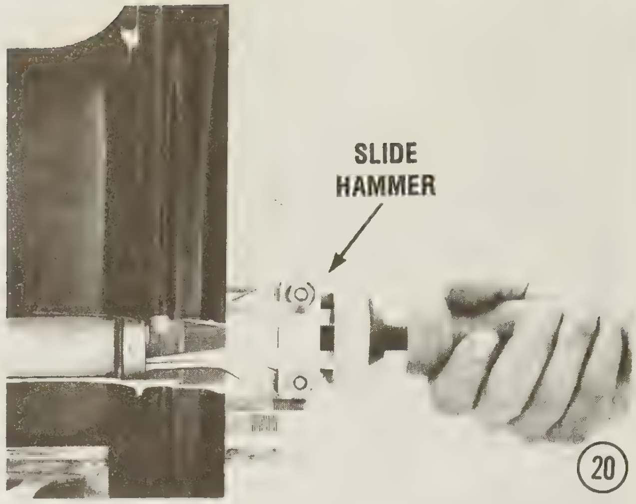
over the nut. Use a breaker bar on the special tool and loosen the nut. Slide the special tool free of the driveshaft, and then back the nut off and clear of the driveshaft.

All UNITS

19- Pull the driveshaft straight up and out of the lower unit. Reach in through the propeller shaft opening and remove the pinion gear.

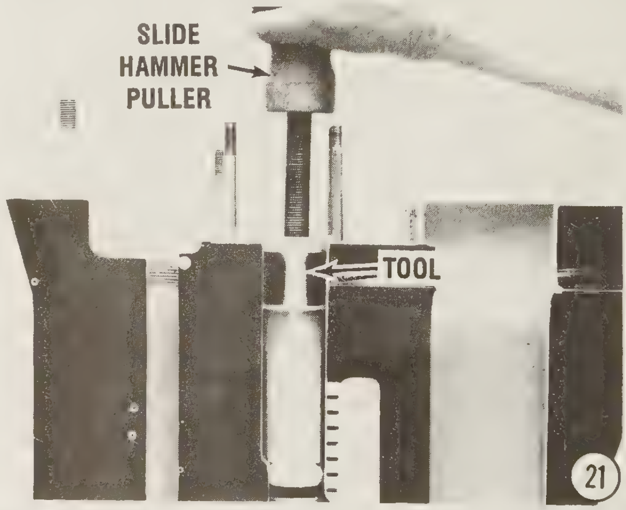
If the driveshaft refuses to come out, an alternate method is to first clamp the driveshaft in a vise equipped with soft jaws. Next, use a block of wood to protect the lower unit and drive the lower unit off the driveshaft. If this method is used, **TAKE CARE** to prevent the lower unit from falling when it finally comes free of the driveshaft.

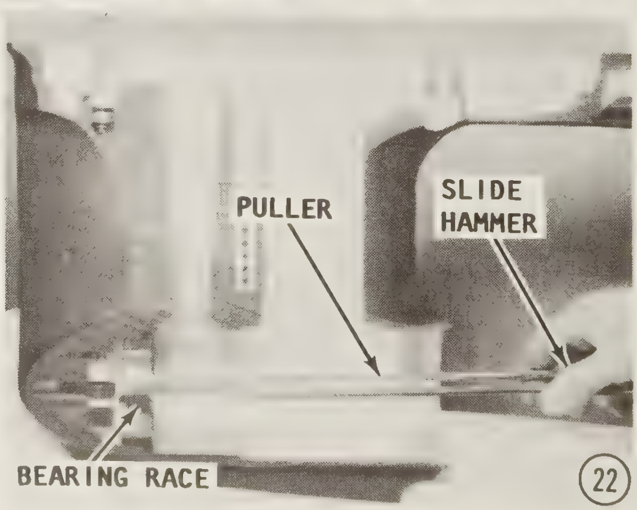


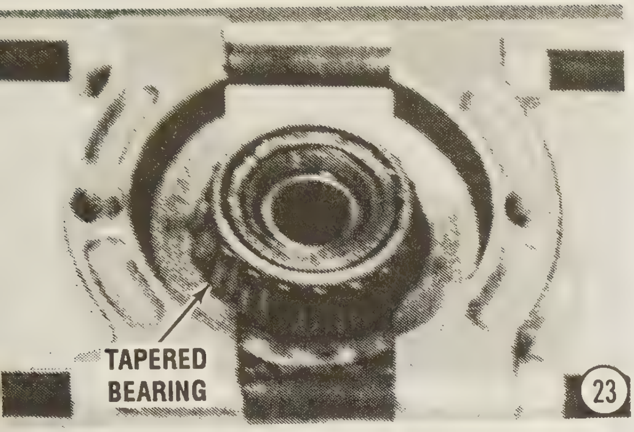


20- Use a slide hammer and remove the driveshaft tapered bearing race. Save the shims from under the tapered bearing race. The same amount of shim material will probably be used during assembling.

21- Obtain Water Pump Cartridge Puller C-91-27780. Use the puller to remove the lubrication sleeve from the lower unit.







Some units may not have this sleeve installed. Set the driveshaft aside for disassembly later.

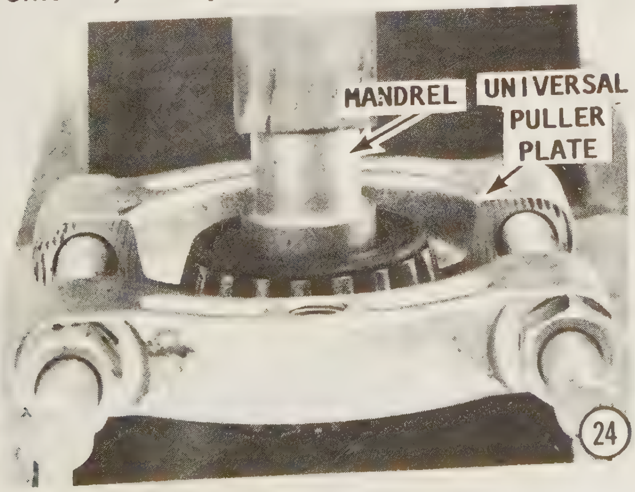
Forward Gear and Bearing Removal

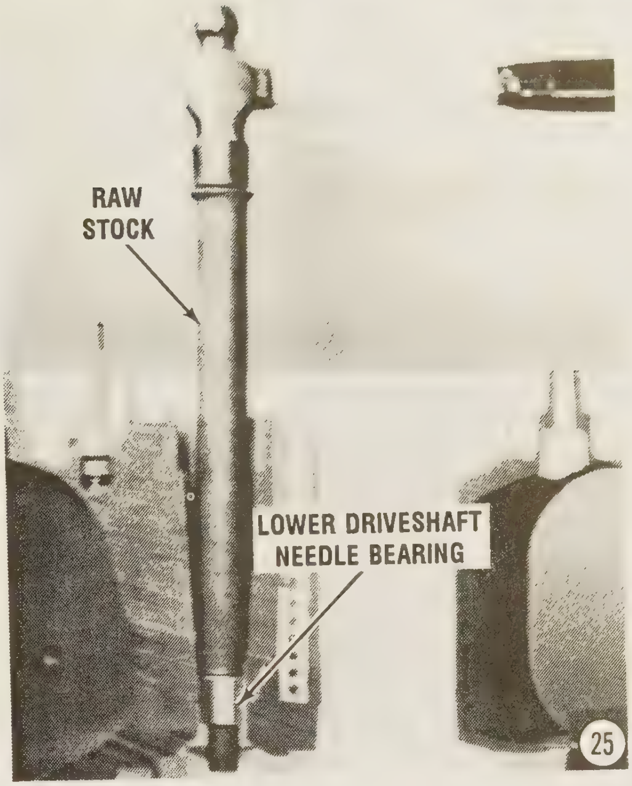
22- After the pinion gear is removed, the forward gear and bearing can be lifted out of the lower unit. The tapered bearing race will remain within the lower unit. **DO NOT** attempt to remove the bearing race unless it is unfit for further service, or the forward gear backlash is far too excessive. Remove the forward bearing race and shim material using a slide hammer.

Separating Forward Gear From Bearing

The forward gear bearing does **NOT** have to be removed to perform an adequate job of cleaning and inspecting. Therefore, it is not necessary to separate the bearing and gear unless either is unfit for further service.

23- Position Universal Puller Plate C-91-37241 between the forward gear and the tapered bearing. Place the puller plate and gear on a press with the gear on the bottom. Press the gear out of the bearing with a suitable mandrel. If the bearing cannot be removed, clamp the forward gear in a vise



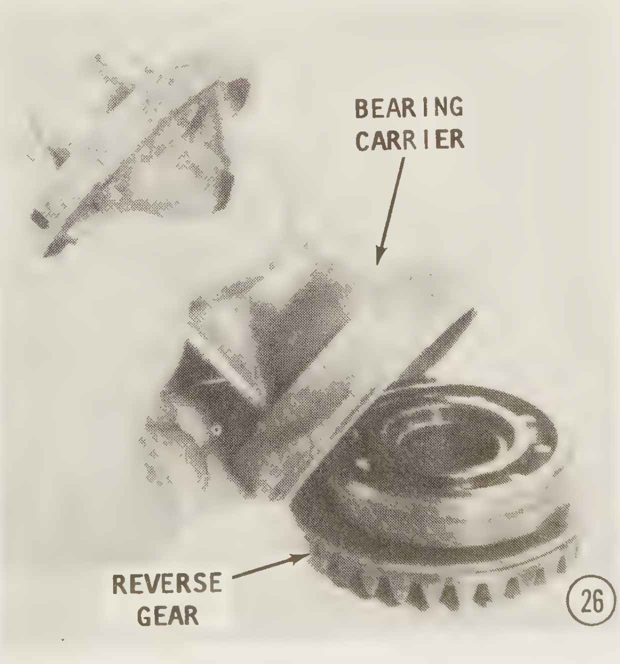


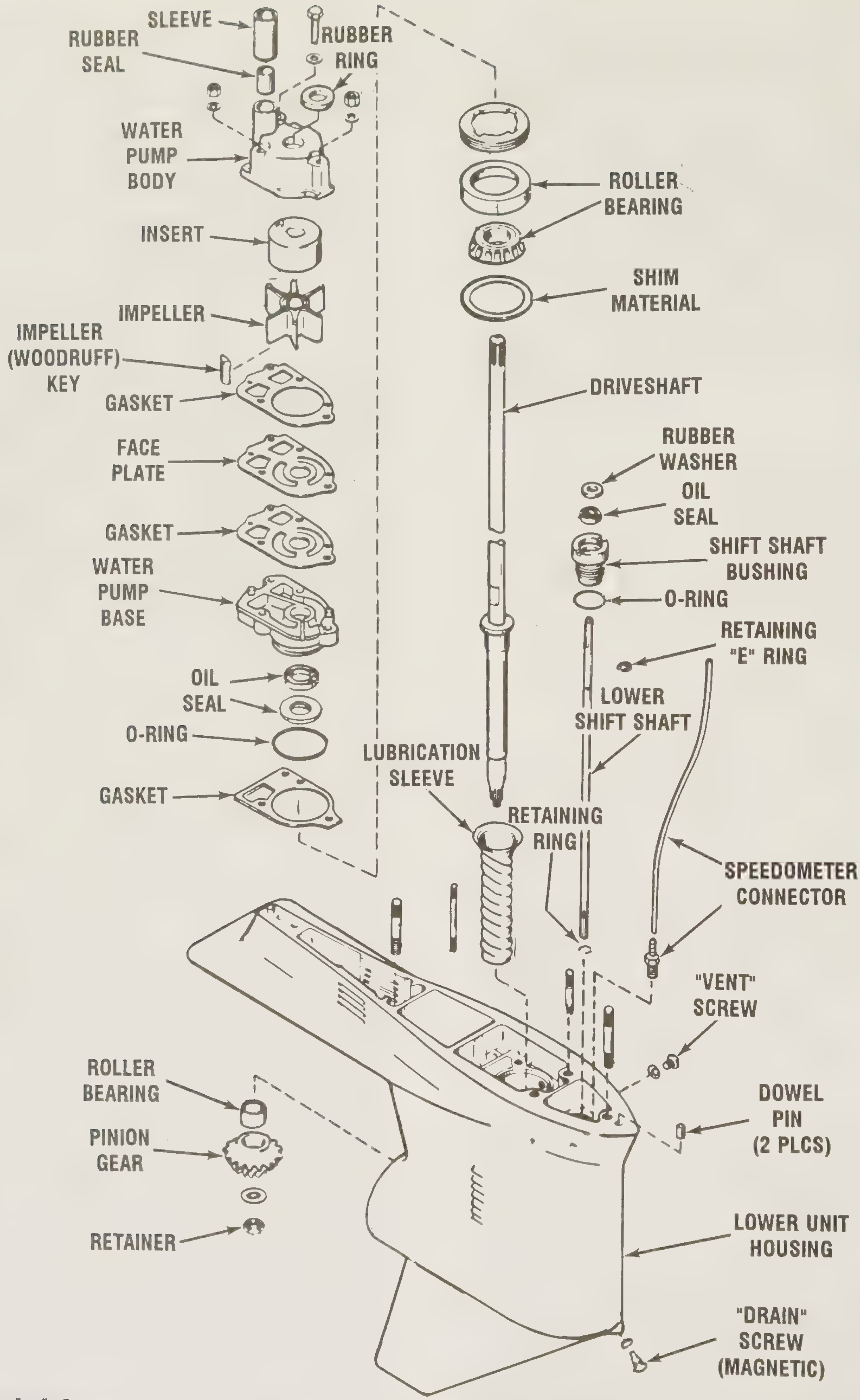
equipped with soft jaws. Use a punch and hammer to drive the roller bearing out of the forward gear.

Driveshaft Disassembling

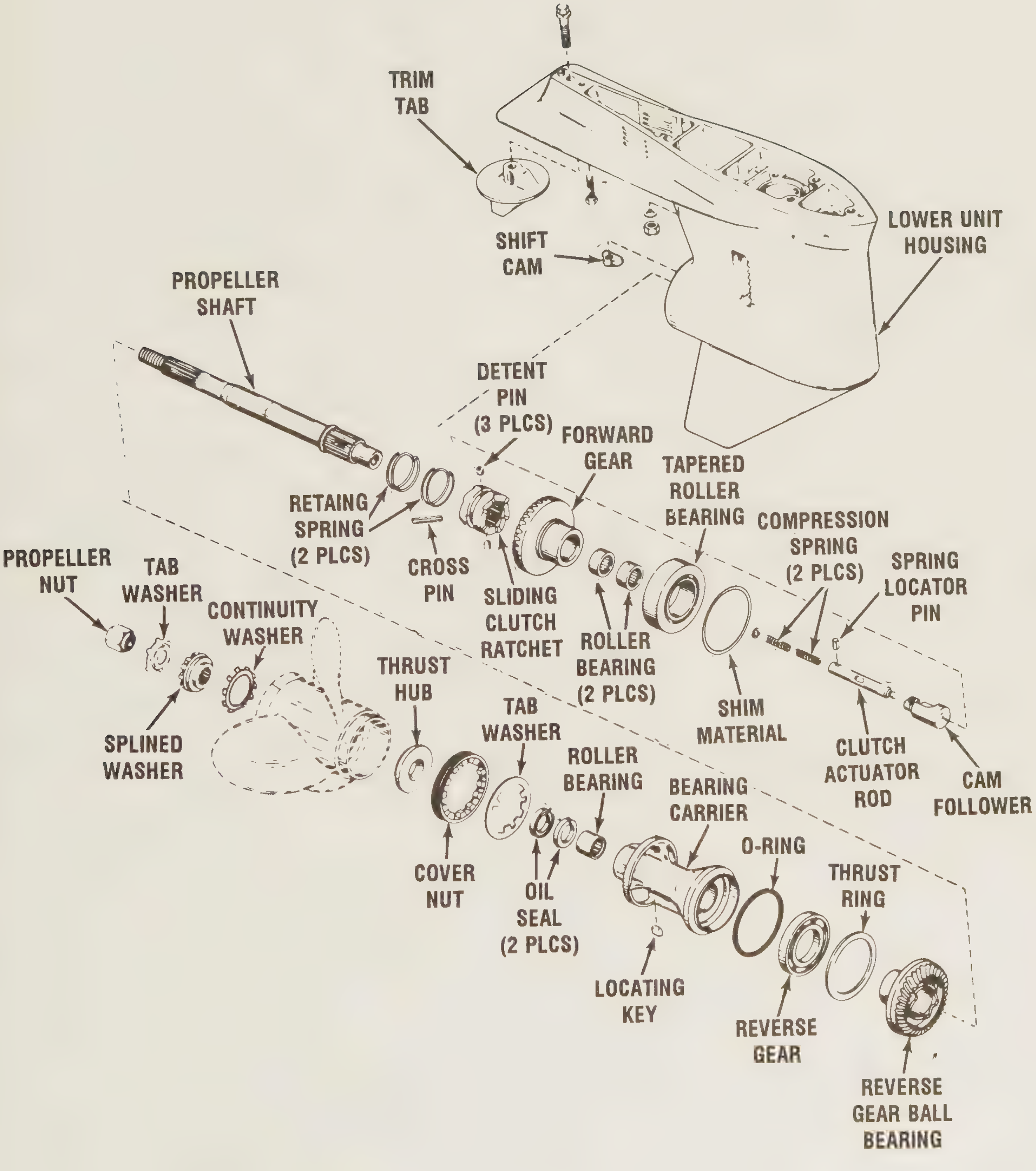
DO NOT remove the driveshaft bearing unless it is no longer fit for further service. If the tapered bearing requires replacement, the bearing race **MUST** also be replaced.

24- Position the driveshaft and Universal Puller Plate C-91-37241 on a press, as

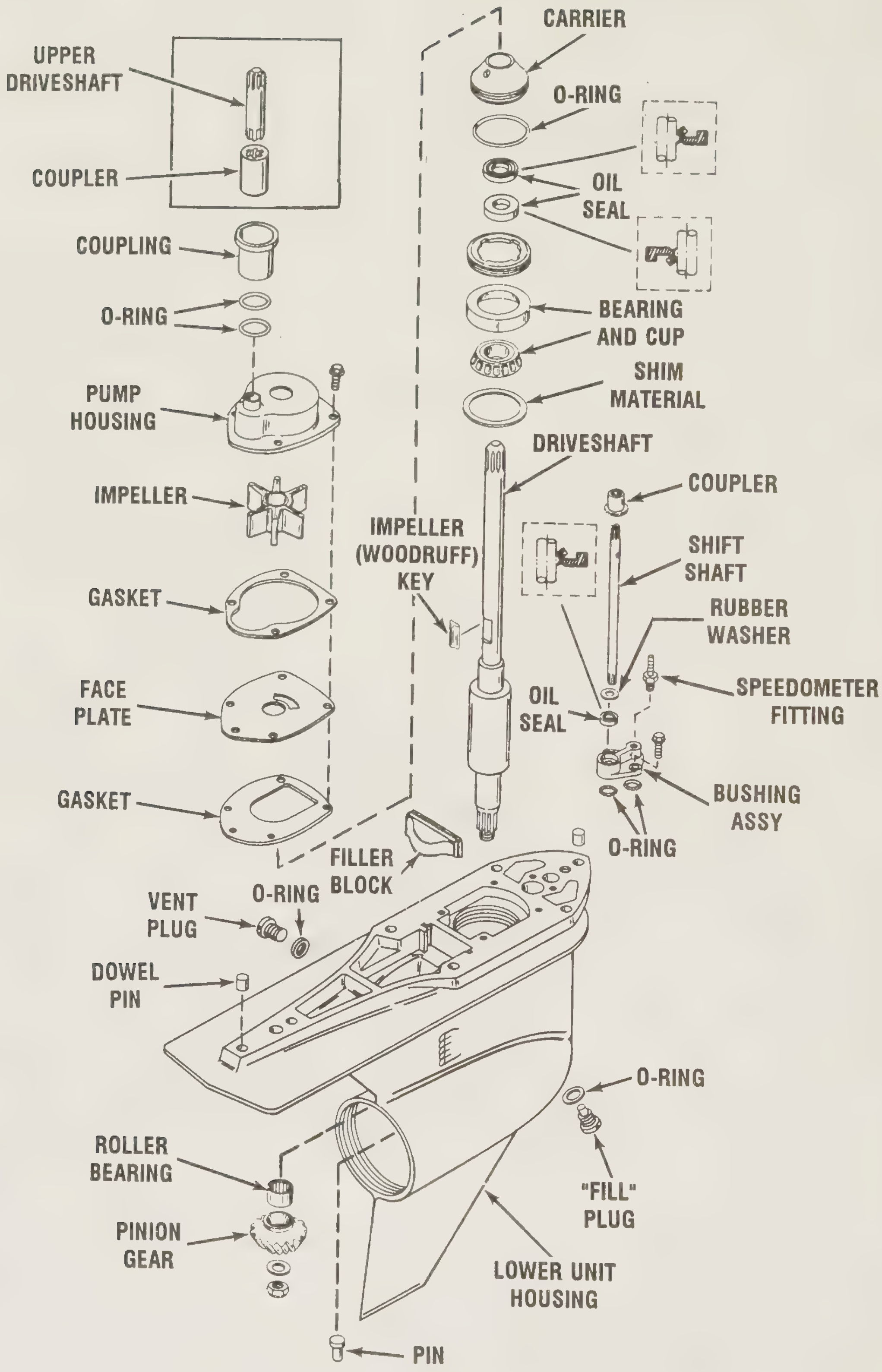




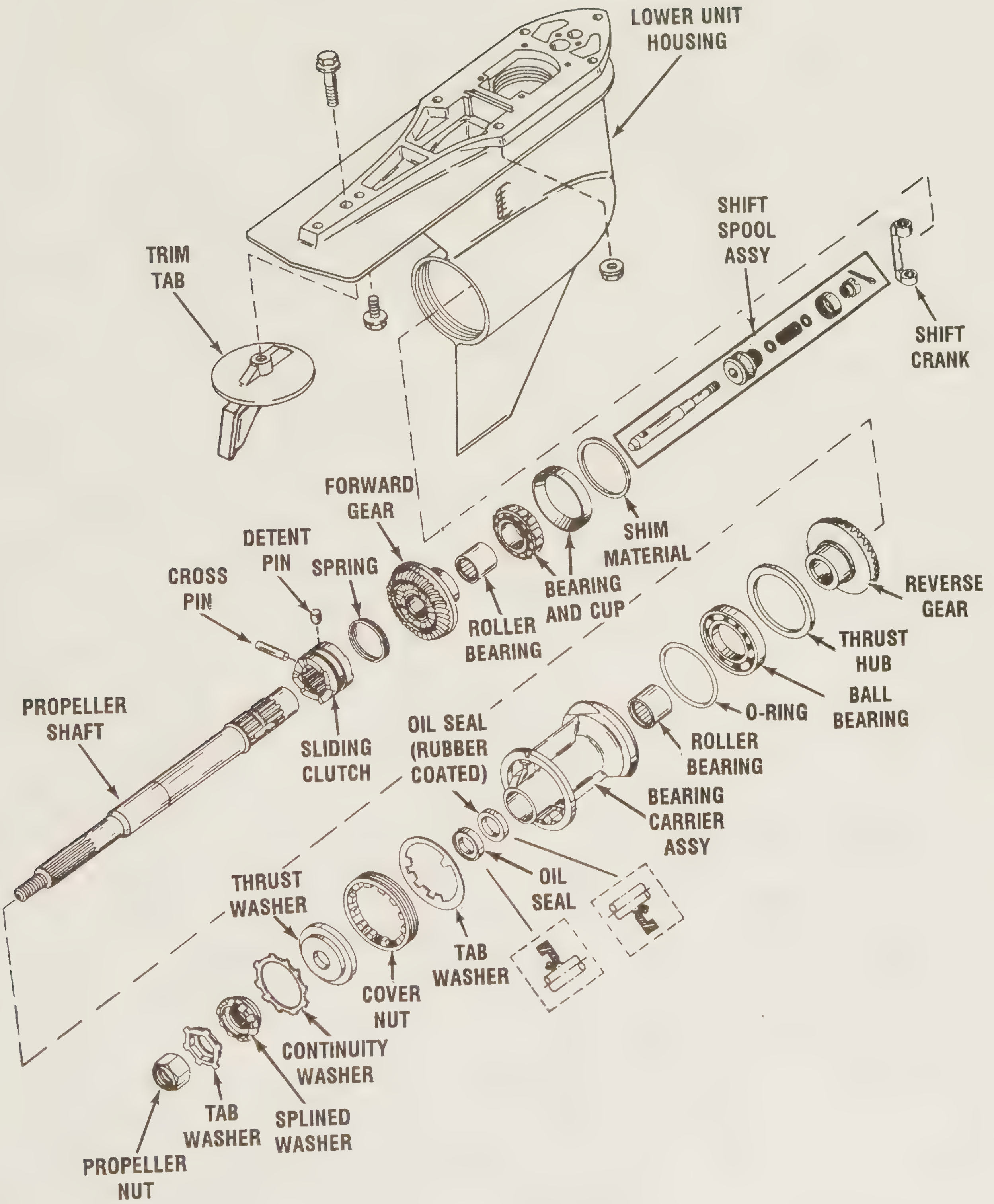
Exploded drawing for the driveshaft and associated parts for the E-Z shift system installed in the lower unit for the ***Model 135, 150, 150XRi/Magnum, 175, 175XRi, 200, 200XRi/Magnum.*** *Major parts are identified. The propeller shaft is shown on the facing page.*



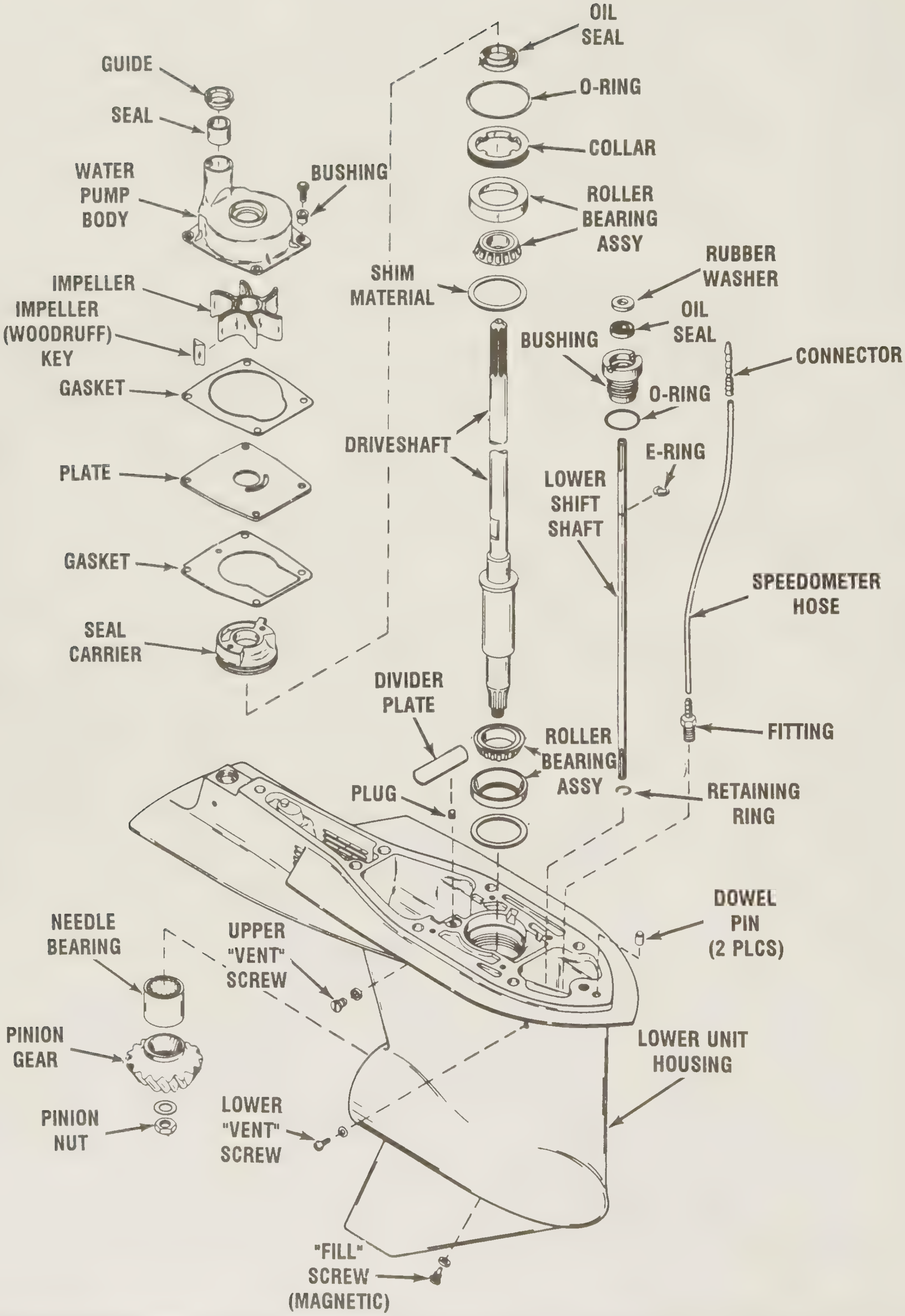
Exploded drawing of the propeller shaft and associated parts for the E-Z shift system installed in the lower unit for the ***Model 135, 150, 150XRi/Magnum, 175, 175XRi, 200, 200XRi/Magnum****. Major parts are identified. The driveshaft is shown on the facing page.*



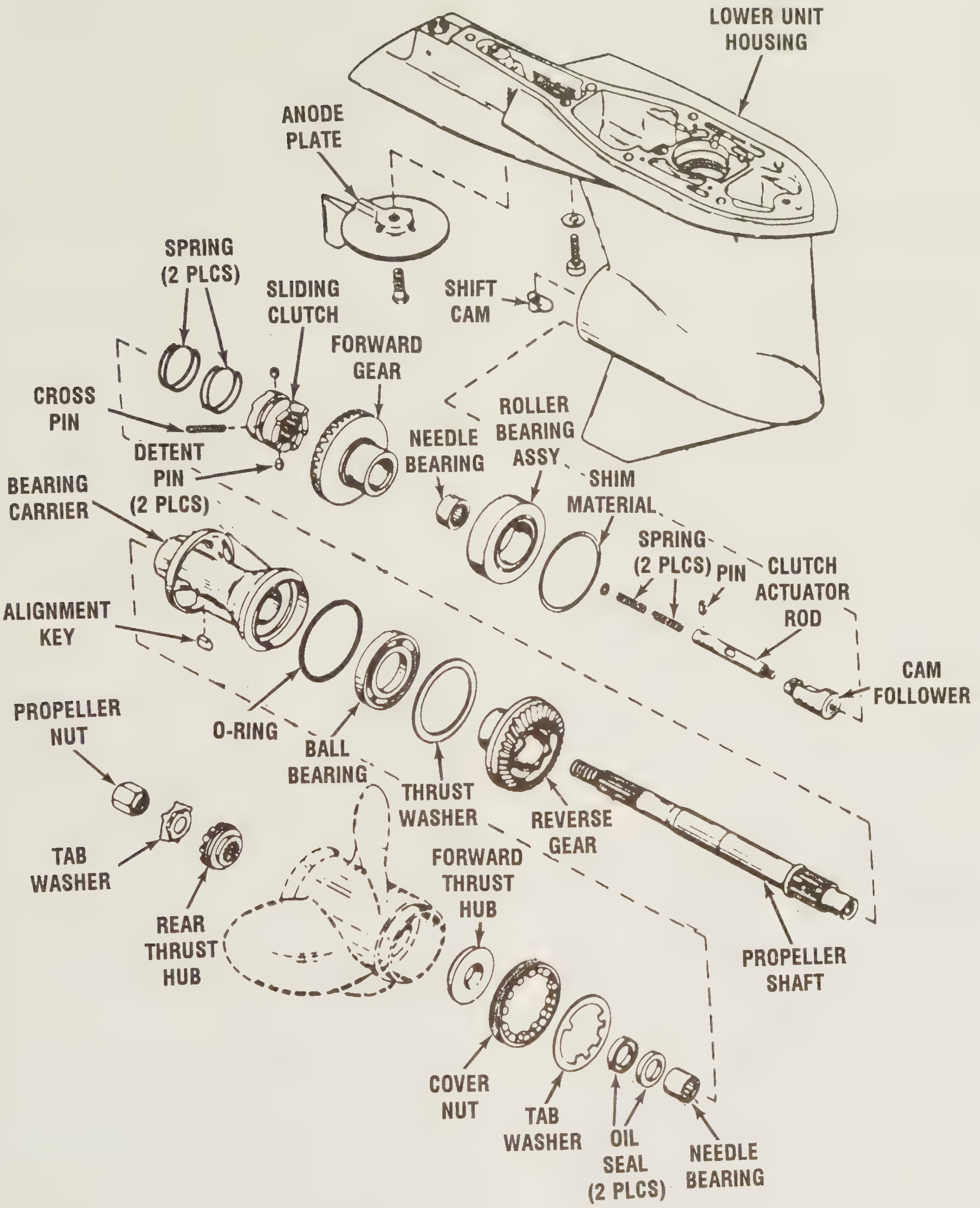
Exploded drawing of the driveshaft and associated parts for the E-Z shift system installed in the lower unit of the ***Model 225hp****. Major parts have been identified. The propeller shaft is shown on the facing page.*



Exploded drawing of the propeller shaft and associated parts for the E-Z shift system installed in the lower unit of the ***Model 225hp****. Major parts have been identified. The driveshaft is shown on the facing page.*



Exploded drawing of the driveshaft and associated parts for the E-Z shift system installed in the lower unit of the ***Model 275hp****. Major parts have been identified. The propeller shaft is shown on the facing page.*



Exploded drawing of the propeller shaft and associated parts for the E-Z shift system installed in the lower unit of the ***Model 275hp.*** *Major parts have been identified. The driveshaft is shown on the facing page.*

shown. Press the driveshaft out of the tapered bearing hub.

BAD NEWS

Once the bearing has been removed it **CANNOT** be used a second time because the roller cage will be damaged during the removal operation. In this case the race will have to be replaced because the bearing and race are a matched set.

25- Use a round piece of raw stock, a wooden dowel will do the job, and drive the lower driveshaft needle bearing out of the housing, as shown.

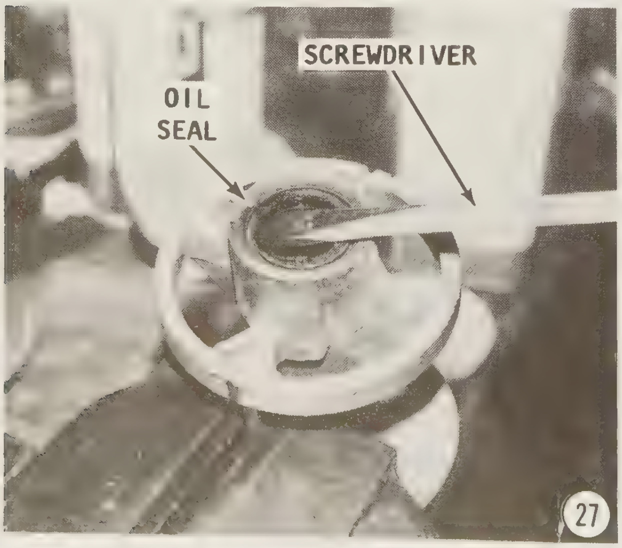
Separating Reverse Gear From Bearing Carrier

26- Clamp the bearing carrier in a vise equipped with soft jaws. Remove and **DISCARD** the O-ring from between the bearing carrier and the thrust washer. Use a slide hammer and remove the reverse gear. If the reverse gear ball bearing remained in the bearing carrier, use a slide hammer and remove the bearing. If the bearing remained on the gear, remove the bearing using a Universal Puller Plate, C-91-37241 and a suitable mandrel to press the gear out of the bearing.

27- Remove the seal by prying or driving it toward the rear. On some late model units, two seals are used. Set the assembly aside ready for cleaning and inspecting.

CLEANING AND INSPECTING

See Section 9-8, beginning on Page 9-67 for detailed, comprehensive procedures to clean and inspect virtually all parts of the lower unit.



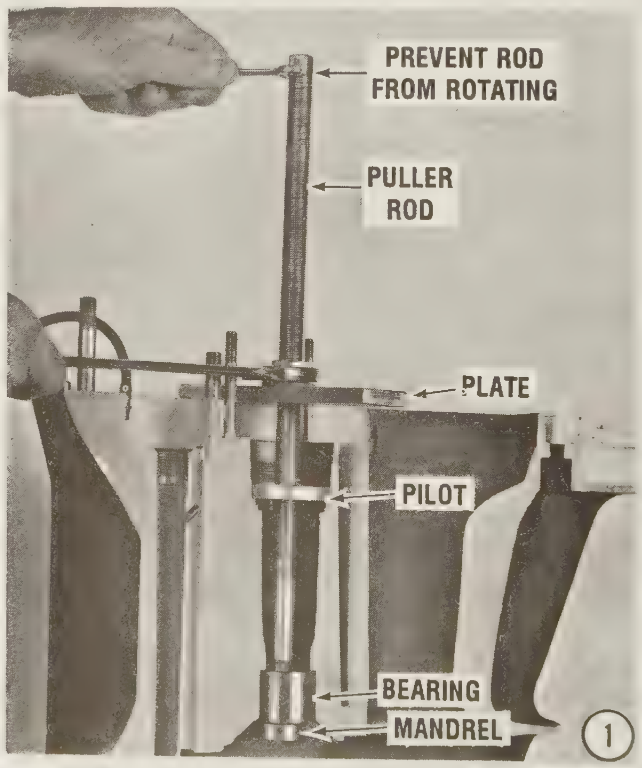
ASSEMBLING AND INSTALLATION E-Z SHIFT LOWER UNIT

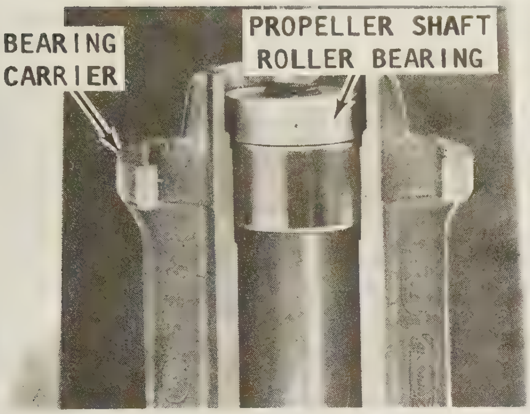
Lower Driveshaft Roller Bearing

1- Obtain Bearing Removal and Installation Tool Kit C-91-31229A5, or similar tools can be made from locally obtained hardware and raw stock. Place puller rod down through the driveshaft bore. Insert bearing with number side pointing towards top of driveshaft bore over the puller rod. Screw mandrel tool P/N 91-92788 onto the end of the puller rod and the center roller bearing onto the mandrel. Slide pilot washer tool P/N 91-36571down the puller rod and center the pilot washer in the upper driveshaft bearing cavity. Install plate tool P/N 91-29310 over the puller rod and down onto the lower unit housing. The plate tool should align with the water pump mounting studs. Thread the puller rod nut down the puller rod until it is flush against the plate. Hold the puller rod from rotating with a wrench. At the same time turn the puller rod nut **CLOCKWISE**. Pull the driveshaft roller bearing **UP** into the bearing cavity until the bearing is flush against the shoulder in the gear case.

Bearing Carrier Assembling

2- Position the propeller shaft roller bearing into the aft end of the bearing carrier with the numbered side **TOWARD** the aft end. Press the roller bearing into the bearing carrier with a suitable mandrel.





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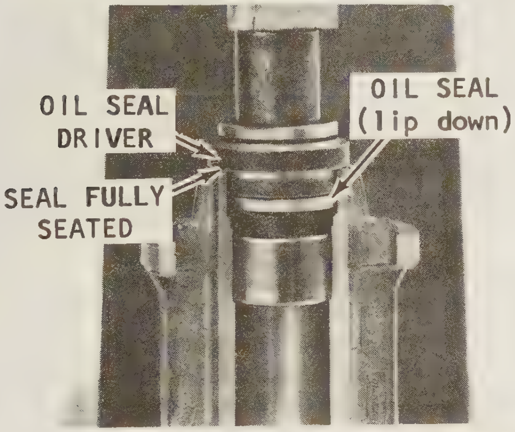

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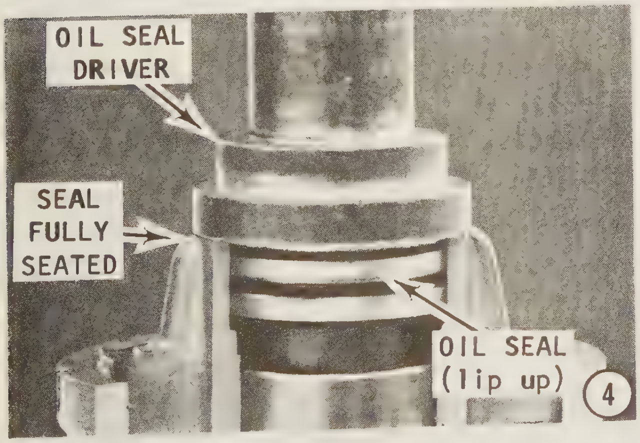

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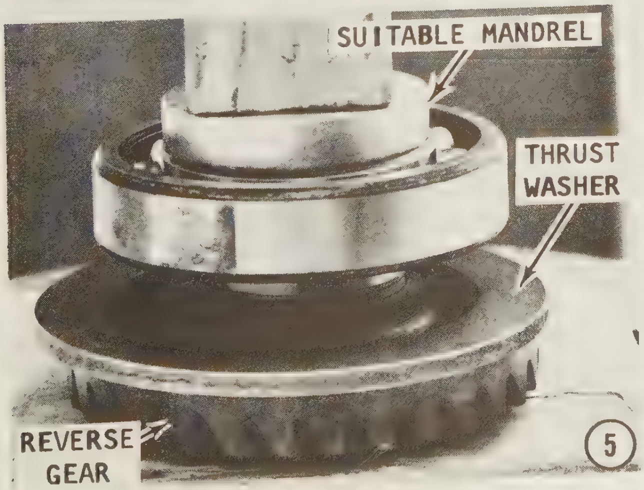

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3- Coat the outer diameter of the propeller shaft oil seals with Blue Loctite. Obtain Oil Seal Driver C-91-31108. Place one seal on the longer shoulder side of the driver tool with the lip of the seal **AWAY** from the shoulder. Press the seal into the bearing carrier until the seal driver bottoms against the bearing carrier. Place the second seal on the short shoulder side of the seal driver with the lip of the seal **TOWARD** the shoulder.

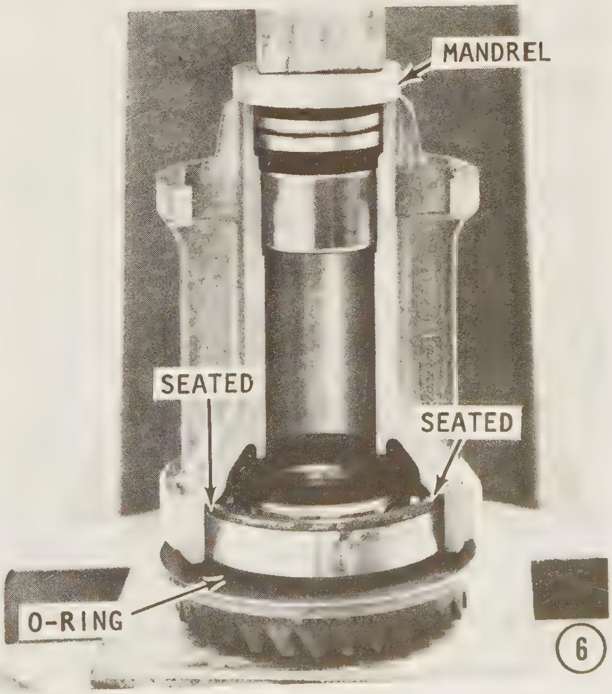
4- Press the seal into the bearing carrier until the seal driver bottoms against the bearing carrier. Clean excess Loctite from the seals.

5- Position the reverse gear on a press with the gear teeth facing **DOWN**. Place the thrust washer over the gear, beveled side **DOWN**. Place the ball bearing over the gear with the numbered side **UP**. Now, press the ball bearing onto the gear with a suitable mandrel.

6- Place the bearing carrier over the gear and bearing assembly. Press the bearing carrier onto the bearing. Place a **NEW** O-ring over the bearing carrier and position it between the bearing carrier and the thrust washer. Coat the O-ring and oil seals with Multipurpose Lubricant, or equivalent. Set the unit aside for installation later.

Forward Gear and Bearing Assembling

7- Place the forward gear on a press with the gear teeth **DOWN**. Position the forward gear tapered bearing over the gear.



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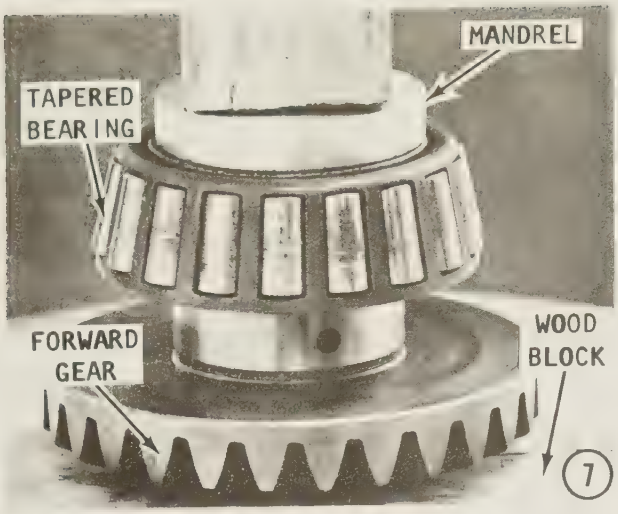
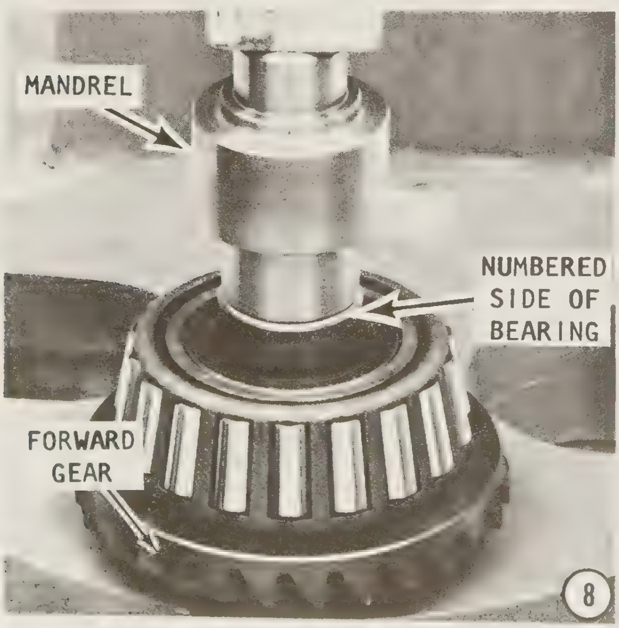


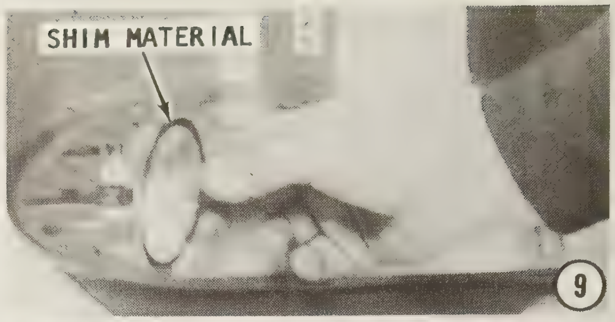
Now, press the bearing onto the gear with a suitable mandrel until the bearing is firmly seated. Check for clearance (gap) between the inner bearing race and the shoulder of the gear. There should be **NO** clearance.

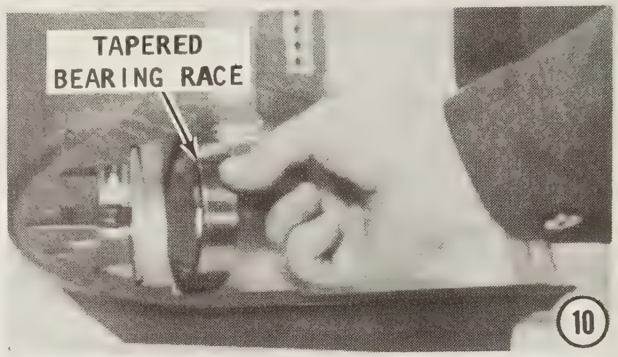
8- Position the roller bearing over the center bore of the forward gear with the numbered side of the bearing facing **UP**. Use a suitable mandrel and press the roller bearing into the gear until the bearing is seated against the shoulder.

CRITICAL WORDS

The bearing carrier is used as a pilot while installing the forward gear bearing cup in the next step. Therefore, the bearing carrier must have been assembled to include at least the propeller shaft roller bearing as outlined in Step 6.



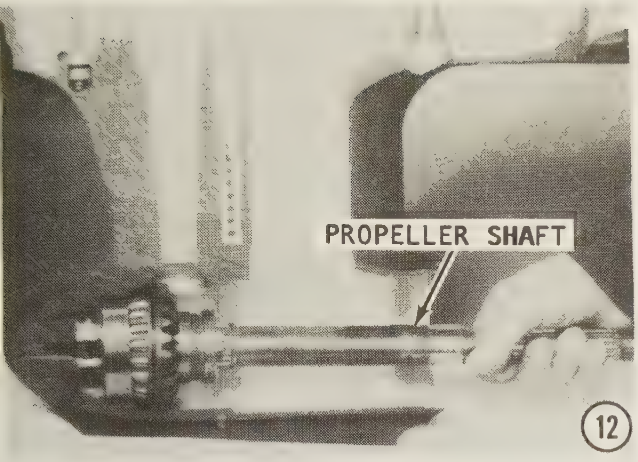




Forward Bearing Race Installation

9- Place the same amount of shim material saved during disassembly into the lower unit. If the shim material was lost, or if a new lower unit is being used, begin with approximately 0.010" (0.25mm) material. Coat the forward bearing race bore with Quicksilver Formula 50-D lubricant, or equivalent.

10- Position the tapered bearing race squarely over the bearing bore in the front portion of the lower unit. Obtain Bearing



Driver Cup tool C-91-31361. Place the tool over the tapered bearing race.

11- Insert the propeller shaft into the hole in the center of the bearing cup. Lower the bearing carrier assembly down over the propeller shaft, and then lower it into the lower unit. The bearing carrier will serve as a pilot to ensure proper bearing race alignment. Now, use a mallet and drive the propeller shaft against the bearing driver cup until the tapered bearing race is seated against the shim material. Withdraw the propeller shaft and bearing carrier, then lift out the driver cup.

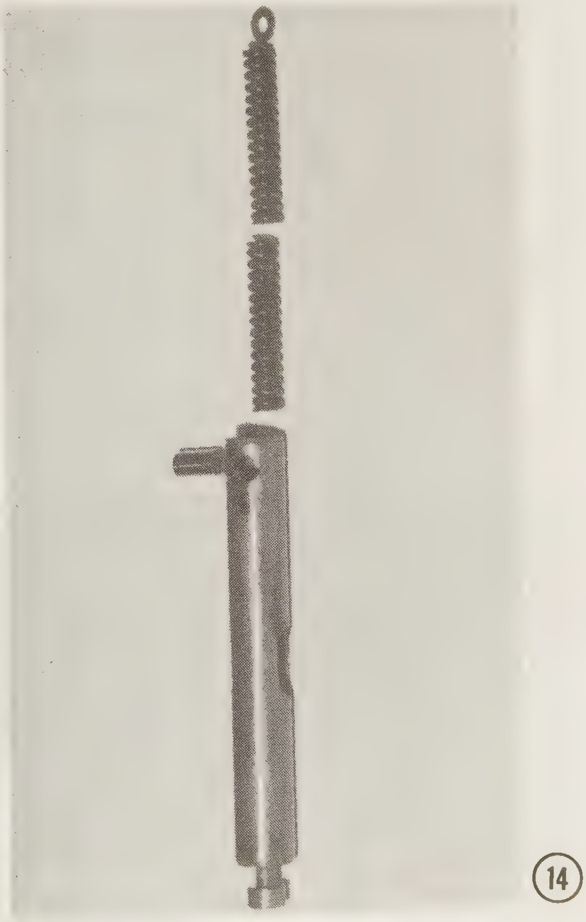
PLAN AHEAD

Obtain a suitable substance which can be used to indicate a wear pattern on the forward and pinion gears as they mesh. Machine dye may be used and if this material is not available, Desenex Foot Powder (obtainable at the local Drug Store/Pharmacy), or equivalent may be substituted. Desenex is a white powder available in an aerosol container. Before assembling either gear, apply a light film of the dye, Desenex, or equivalent, to the driven side of the gear. After the gears are assembled and rotated several times, they will be disassembled and the wear pattern can be examined. The substance will be removed from the gears prior to final assembly.

12- Position the forward gear assembly into the forward bearing race.

Propeller Shaft Assembling

13- Move the sliding clutch onto the propeller shaft with the grooves facing toward the propeller end of the shaft, as shown. As the clutch goes onto the shaft, the internal splines of the clutch will index



with the splines on the propeller shaft. Check to be sure the hole through the clutch aligns with the slot in the shaft. If it does not, slide the clutch free of the shaft, rotate the clutch one spline, right or left, and then slide it on again. If it is not possible to align the hole with the slot, slide the clutch free, rotate the shaft 90° to a new set of holes and try again. The hole in the clutch and the slot in the shaft will only align in **ONE** position. Naturally, when the correct set of holes through the clutch are aligned with the slot and the proper splines are indexed. The detent holes in the sliding clutch will also align with the notches in the propeller shaft.

14- To assemble the actuator rod, first arrange the parts, as shown. Notice how the locating pin has one flat side. This flat must bear against the end of the last spring to go in.

15- Slide the two springs into the actuator rod. The springs are identical, either one in first, and either end in first. Insert the shim washer into the rod to seat on top of the spring. Coat the locating pin with a small amount of Multipurpose Lubricant. Now, slide the locating pin through the rod with the flat side facing toward the springs. Once in place, the flat of the pin will bear against the shim washer.

16- Insert an awl through the slot in the actuator rod to separate the two springs. Work the awl from one side and the cross pin from the other side and push the cross through the slot. Measure the distance from each edge of the cross pin to the end of the slot on that side. The measurements must be equal with 1/64" (0.4mm). To shift the pin one way or the other, the rod is disassembled, and an additional shim washer placed in one end or the other to shift the

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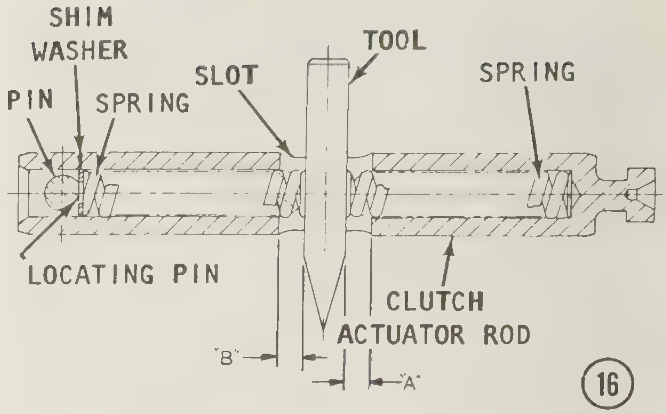
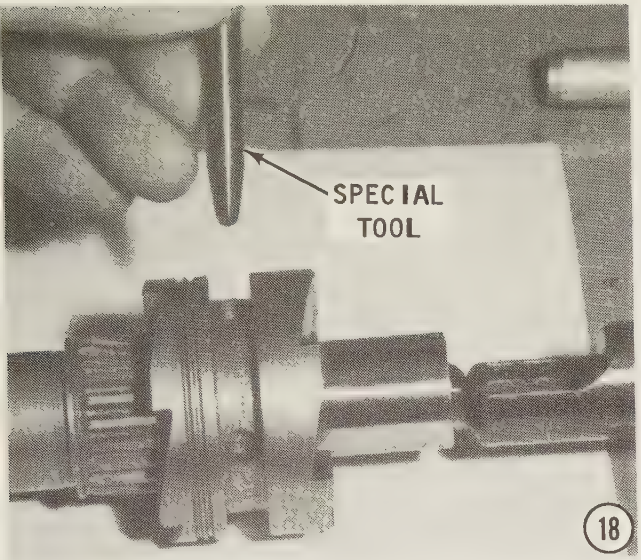


16

cross pin in the opposite direction. The illustration shows the use of special cross pin tool No. C-91-86642.

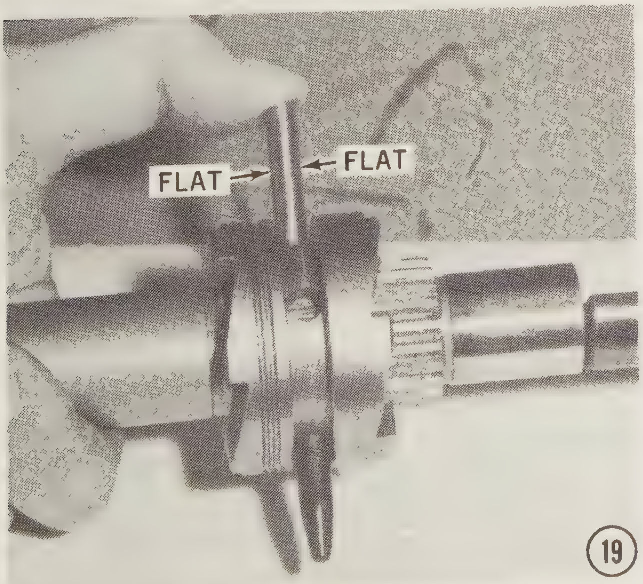
17- Move the clutch back onto the propeller shaft to expose the slot. Insert the actuator rod part way into the propeller shaft. Rotate the rod to roughly align the slot with the hole in the clutch. Install the cam follower onto the end of the actuator rod, and then push the rod further into the propeller shaft. Rotate the actuator rod to align the cross pin slot in the rod with the slot in the propeller shaft, and the hole in the sliding clutch.

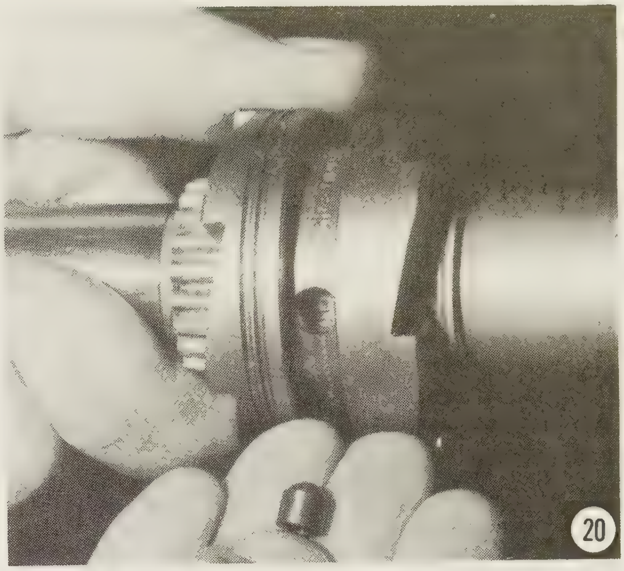
17



18- Obtain special cross pin tool No. C-91-86642. If this tool is not available obtain some type of pointed pin of sufficient size to spread the springs in the actuator rod apart to allow the cross pin to be inserted. A possible makeshift tool would be to cut off the shank of an appropriate size screw-driver. Insert the special or makeshift tool through the sliding clutch and spread the springs in the actuator rod.

19- Observe how the cross pin has two flat sides opposite one another. These flats must bear against the springs in the actuator rod. Now, start the cross pin with the flats facing to bear against the springs in the actuator rod. Push the cross pin into the hole immediately behind the tool. As the cross pin moves into place the special tool will be forced out. After the tool is free and both ends of the cross pin are flush





with the surface of the sliding clutch, the task is complete.

20- Apply just a dab of Multipurpose Lubricant onto each detent pin. Observe how each pin has a rounded end and a flat end. Insert the two pins into the two detent holes of the sliding clutch with the rounded end going in first, toward the propeller shaft.

21- Observe the two retaining springs. Notice how each has a bent tang on one end. The other end is straight.

SPECIAL WORDS

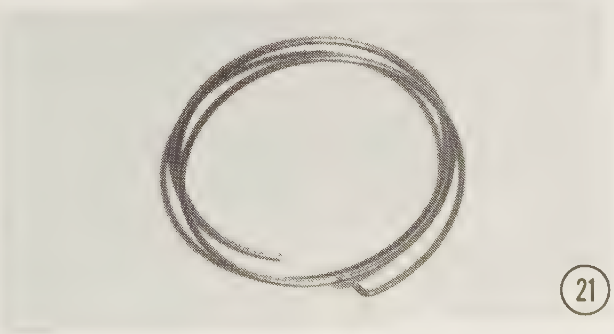
The retaining springs are identical. **HOWEVER**, one spring is wound into place in a clockwise direction and the other in a counterclockwise direction. Once in place, the following conditions **MUST** be met:

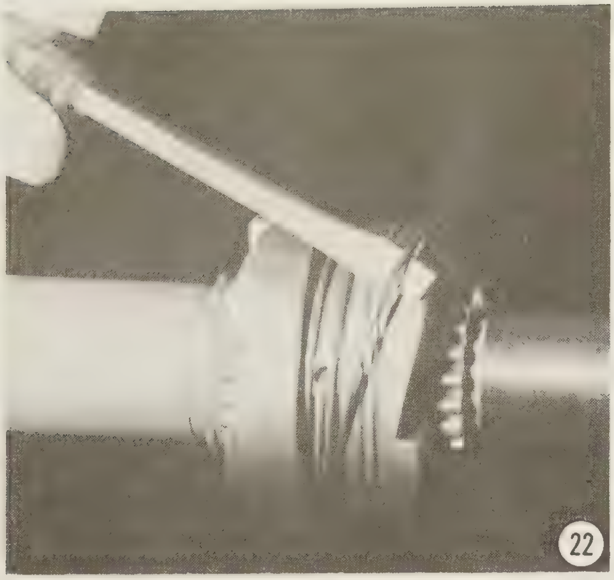
a- The springs must be wound in opposite directions.

b- The tang of each spring must be indexed into the detent of one detent pin.

c- The straight end of each spring must lie against the wall of the groove.

d- The spring coils must not overlap each other or the other spring.



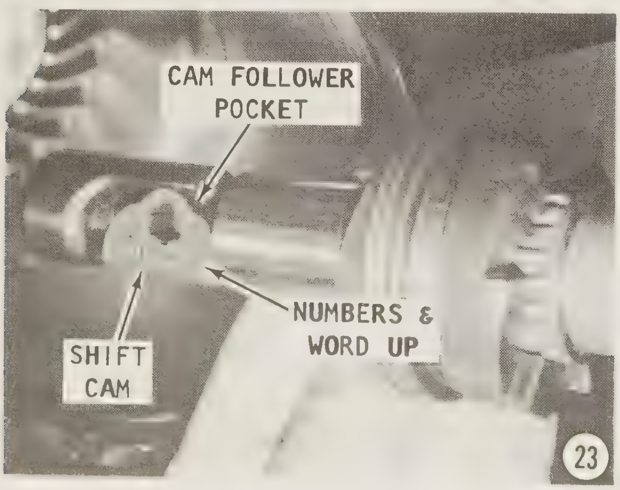


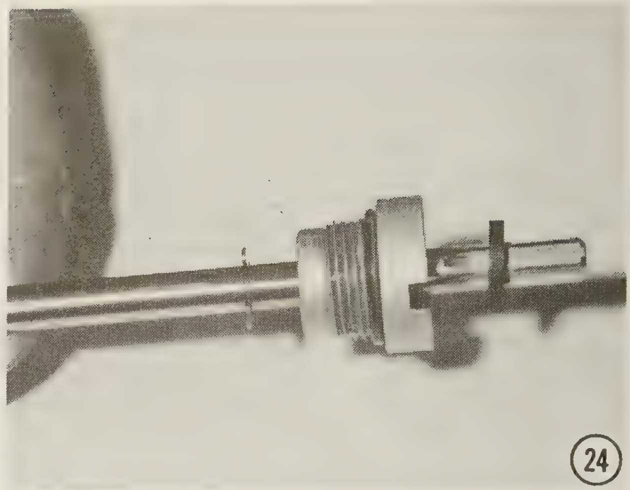
Take care not to over stretch the retaining springs as they are being installed onto the sliding clutch.

22- Slide one spring over the propeller shaft, and then insert the tang end into the detent hole that will permit the straight end of the spring to lie against the groove wall. Insert a screwdriver under the spring and wind it into place by rotating the propeller shaft. These wraps of the spring will also hold the second detent in place during installation.

After the first spring is in place, slide the second spring over the opposite end of the propeller shaft. Index the tang end of the spring into the detent of the second detent pin. Wind the spring into place with the screwdriver and by rotating the propeller shaft in the opposite direction.

Check to be sure one coil of either spring is not overlapped with its own spring or a coil of the other spring. Work the coils

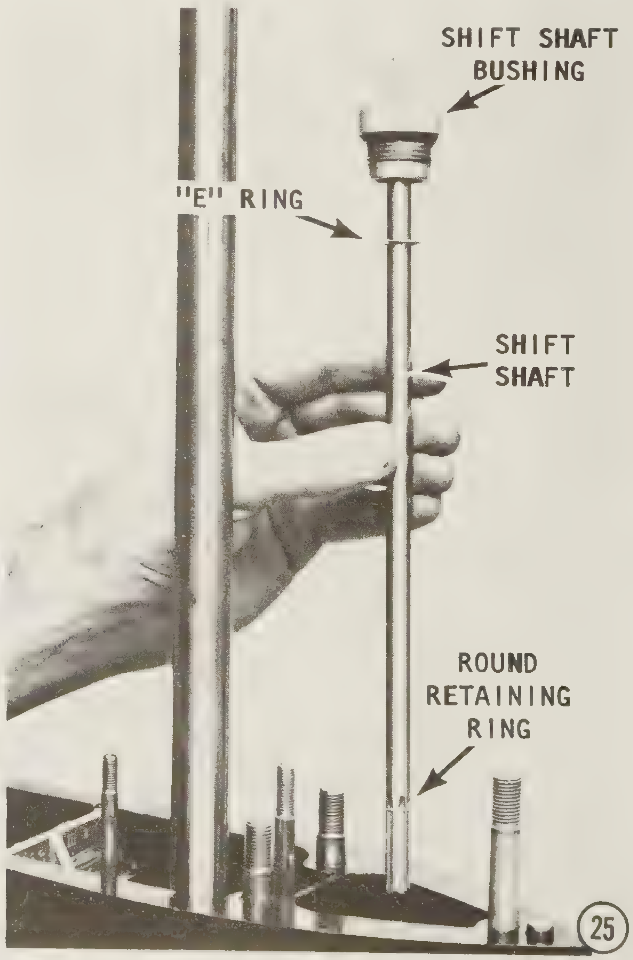


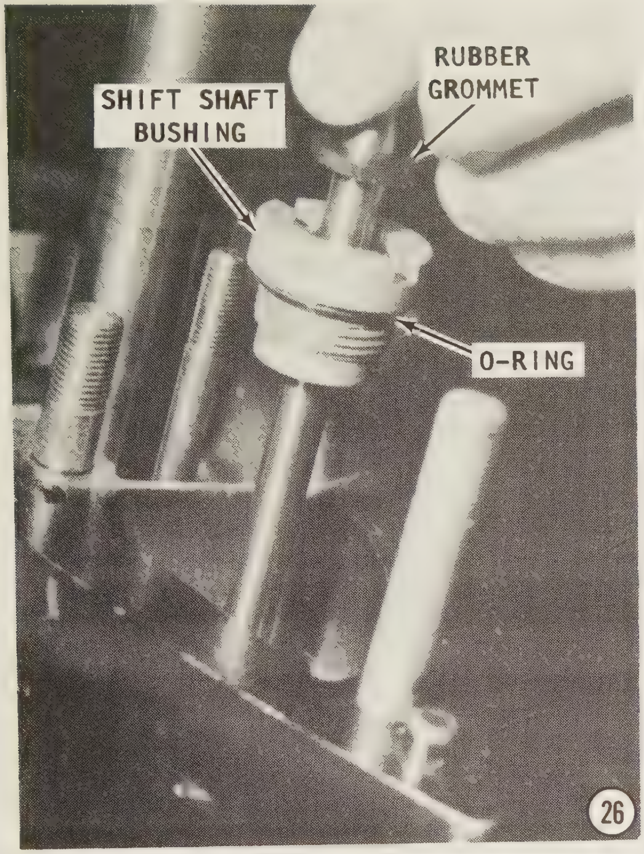


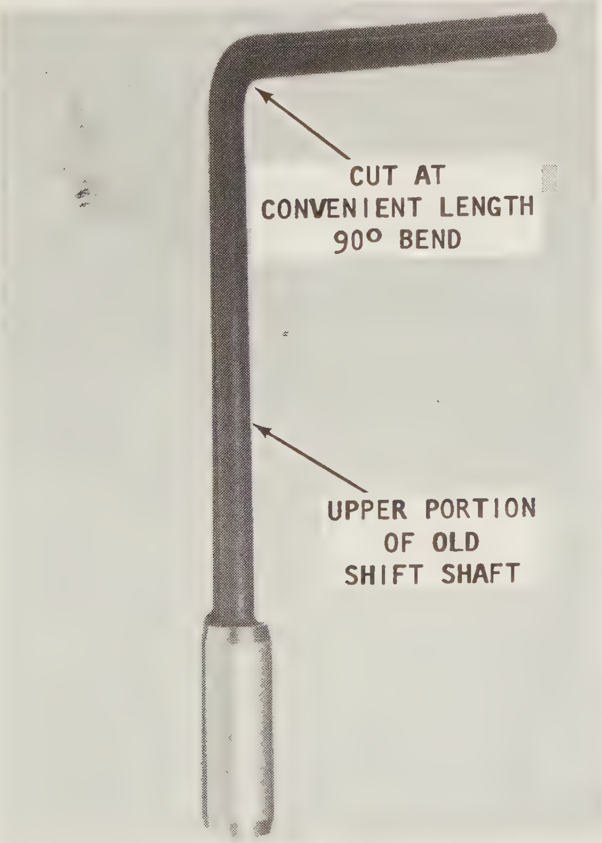
to lay individually in the sliding clutch groove.

To verify the parts have been assembled correctly, push the sliding clutch first in one direction and then in the other. You should be able to feel the detents move into place in each direction for forward and reverse gear engagement.

23- Coat the cam pocket of the cam follower with Multipurpose Lubricant. This lubricant will hold the shift cam in place







An old shift shaft, cut and bent to form a special tool to rotate the shift shaft without damaging the shift shaft splines. If this tool cannot be made, use a piece of soft metal and pair of pliers.

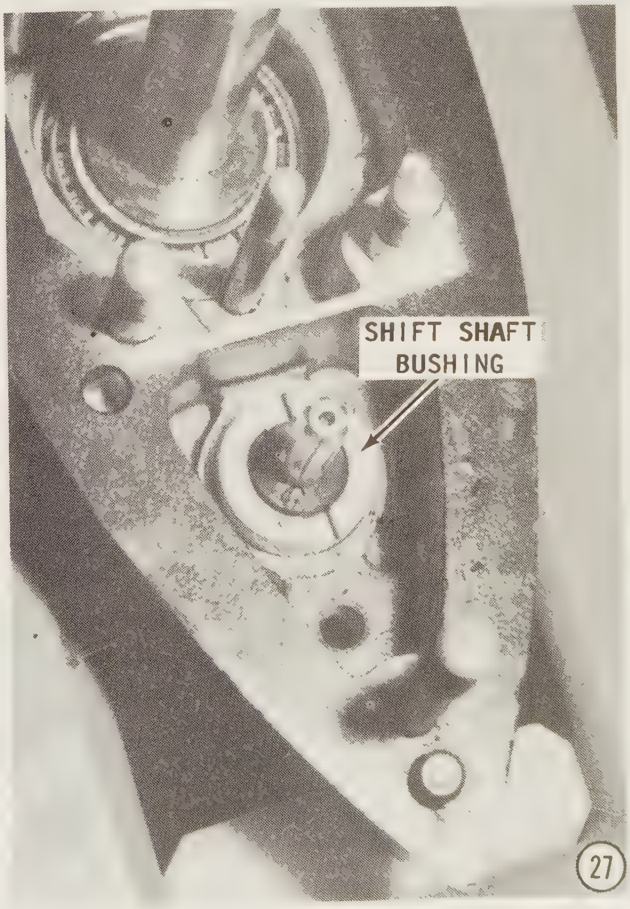
during installation of the propeller shaft into the lower unit housing. Observe the numbers and the word "UP" embossed on one surface of the shift cam. Insert the shift cam into the cam pocket with the numbers and the word "UP" facing up, as shown.

Gently insert the propeller shaft into the lower unit housing with the shift cam in as close to a horizontal position as possible. Continue to move the propeller shaft into place until the forward end of the shaft seats in the bearing.

24- Slide the shift shaft bushing and the rubber grommet onto the shift shaft, if it was removed. Install a **NEW** O-ring onto the shift shaft bushing.

25- Check to be sure the round retaining ring on the lower end of the shift shaft and the E-clip at the upper end are securely in place.

26- Use a flashlight and look down through the opening for the shift shaft and verify the hole in the shift cam is properly positioned to receive the shift shaft when the shaft is installed. If the hole is not aligned, rotate the propeller shaft slightly until the hole is aligned. **SLOWLY** slide the shift shaft down through the lower unit



opening. Continue moving the shift shaft downward and the splines on the end of the shaft will index with the splines in the shift cam.

SPECIAL WORDS

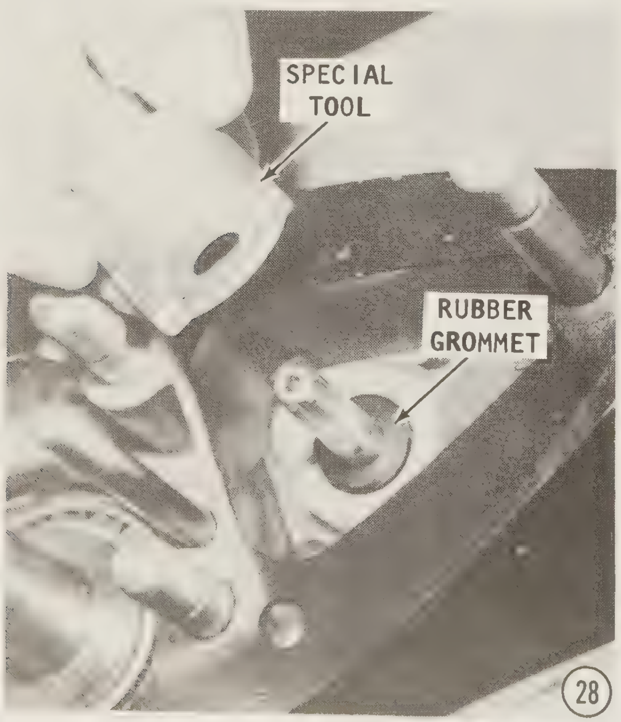
It may be necessary to rotate the shift shaft ever so slightly to permit the shift shaft splines to index with the shift cam splines.

To ensure the shift shaft is properly indexed with the shift cam, use the special tool made during disassembly from the upper portion of an old shift shaft, as shown in the accompanying illustration. If the tool was not made, wrap a piece of soft metal, such as aluminum, around the end of the shaft to protect the splines, and then use a pair of pliers. Rotate the shaft back and forth, with the tool or pliers. As the shift shaft is rotated, observe the propeller shaft moving slightly in and out of the lower unit housing. Movement of the propeller shaft ensures correct assembly work.

CRITICAL WORDS

While the propeller shaft is in the lower unit and until the bearing carrier is installed, **TAKE CARE** not to bump or apply any side force on the propeller shaft. A side force on the shaft may break the neck of the clutch actuator rod.

27- Apply a light coating of Perfect Seal to the threads of the shift shaft bushing. **TAKE CARE** to prevent the Perfect Seal from contacting the bushing oil seals or the O-ring. Rotate the bushing by hand to prevent cross threading.



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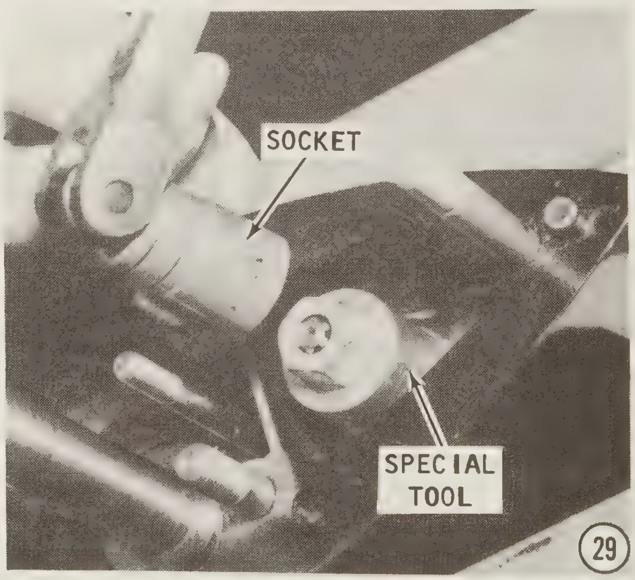
28- Push the rubber grommet down the shift shaft until it seats in the shift shaft bushing. Obtain special tool No. C-91-31107.

29- Tighten the bushing just snug using the special tool and the proper size socket. If the special tool is not available, use a blunt punch indexed in one of the slots at the outside edge of the bushing, and a hammer. Use quick, sharp, decisive blows to tighten the bushing. **REMEMBER**, tighten the bushing just snug.

Driveshaft Assembling and Installation

30- If the tapered roller bearing was pressed off the driveshaft, install the bearing onto the driveshaft, as follows:

Apply a light coating of bearing lubricant to the inside surface of the driveshaft tapered bearing.



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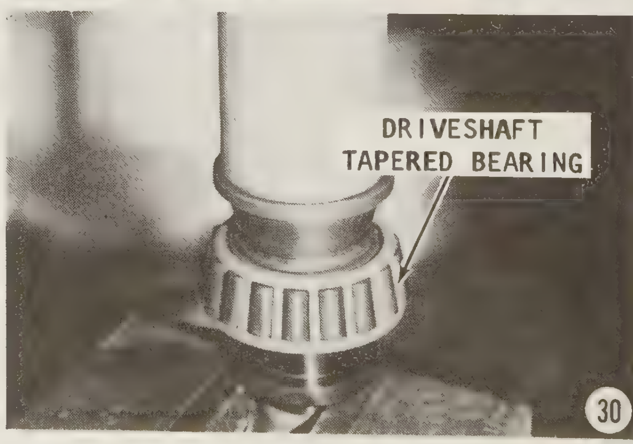

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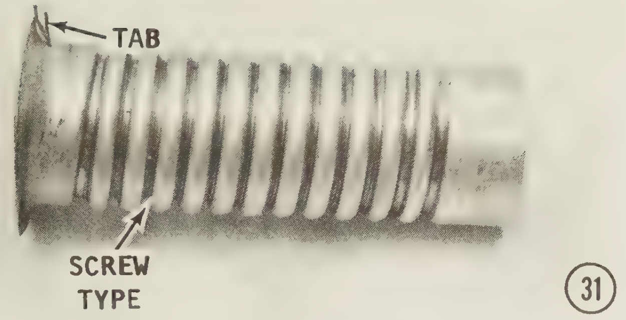


Apply a light coating of bearing lubrication to the inside surface of the driveshaft tapered bearing. Insert the driveshaft into a suitable adapter with the driveshaft pinion end shoulder against the adapter. Use a suitable mandrel and press against the inner bearing race. Continue moving the bearing onto the driveshaft until the bearing is seated against the surface of the shoulder.

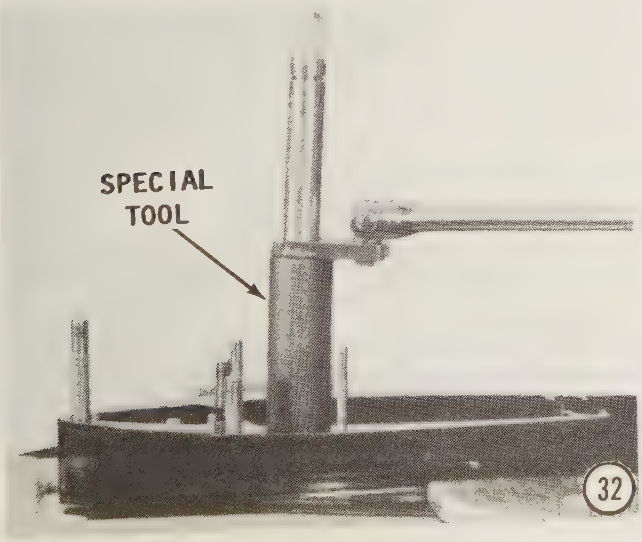
Driveshaft Installation

31- Insert the lubrication sleeve into the driveshaft cavity.

GOOD WORDS ON LUBRICATION SLEEVES

The lubrication sleeve has a pattern on the outside surface resembling the threads of a large screw. Therefore it is referred to as a "screw" pattern. When this "screw" pattern sleeve is installed, the tab on the sleeve **MUST** be aligned with the slot in the driveshaft bore.

CHECK to be sure the sleeve fits down into the cavity far enough to be below the shim material surface. **DO NOT** use excessive force because the sleeve could be distorted.



32- Install the bearing retainer nut with the word **OFF** facing **UP**. Obtain bearing retainer nut tool P/N C-91-43506. Secure the retaining nut by tightening it with the special tool to a torque value of 100 ft lb (135.6Nm).

STOP!

Obtain a suitable substance which can be used to indicate a wear pattern on the forward and pinion gears when they mesh. The technique and substance is explained in the "Plan Ahead" paragraph prior to Step 12. Machine dye may be used and if this material is not available, Desenex® Foot Powder, or equivalent may be substituted. Desenex® is a white powder available in an aerosol container at the local drug store or pharmacy.

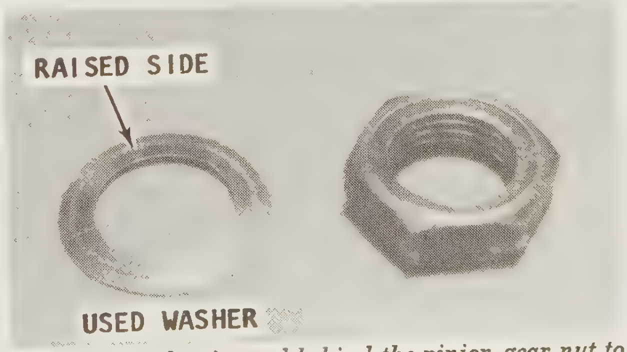
Apply a light film of the dye, Desenex®, or equivalent, to the driven side of the pinion gear. After the gears are assembled and rotated several times, they will be disassembled and the wear pattern can be examined. The substance will be removed from the gears prior to final assembly.

ALL UNITS

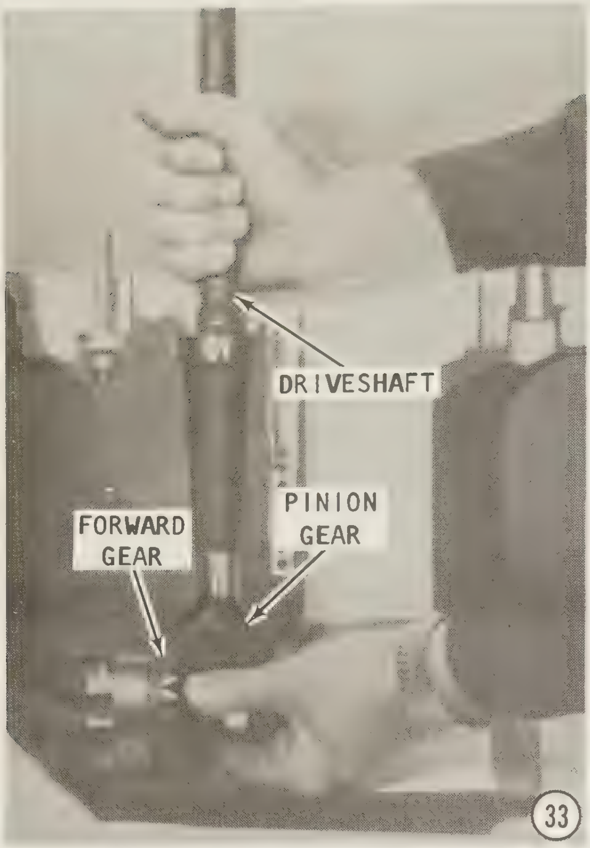
33- With one hand, lower the driveshaft into the top of the lower unit. With the other hand, hold the pinion gear up in the lower unit with the teeth of the gear indexed (meshed), with the teeth of the forward gear. Now, rotate and insert the driveshaft until the driveshaft splines align and engage with the splines of the pinion gear. Continue to insert the driveshaft into the pinion gear until the tapered bearing cage is against the housing.

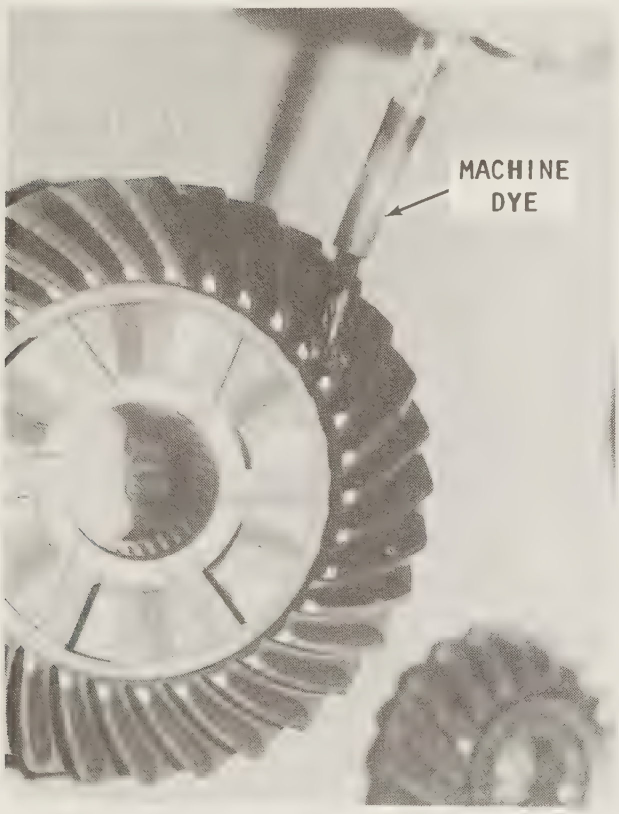
WORDS FOR PINION GEAR ASSEMBLY

A thin washer is used on the pinion gear to more evenly distribute the load of the nut

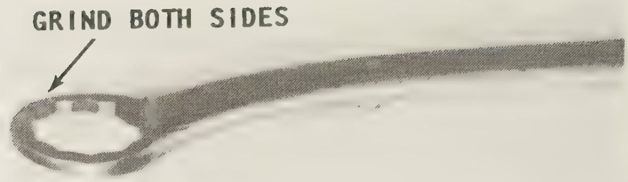


*A flat washer is used behind the pinion gear nut to distribute the load. If a used washer is to be installed, the raised side **MUST** face the nut. The pinion nut should **NEVER** be used a second time, because after one use, it loses its full locking ability.*





Machine dye being applied to one of the driven gears in preparation to obtaining a gear mesh pattern with the pinion gear. Desenex® Foot Powder may also be used, as explained in the text.



A modified box-end wrench used to remove/install the pinion gear nut, if the special tool mentioned in the text is not available.

against the pinion gear. When the washer is new, both sides are flat. However, after use, one side becomes slightly concave, the other side raised. When a used washer is installed, **BE SURE** the raised side is facing towards the pinion gear; the concave side facing the nut.

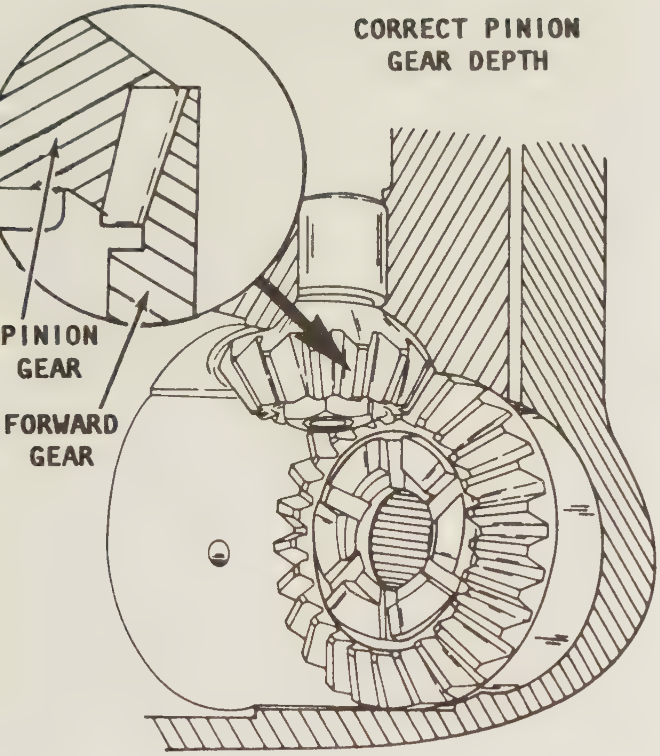
A pinion nut **CANNOT** be used a second time. After one use, it loses some of its self locking ability. Therefore, **ALWAYS** use a new pinion gear locking nut.

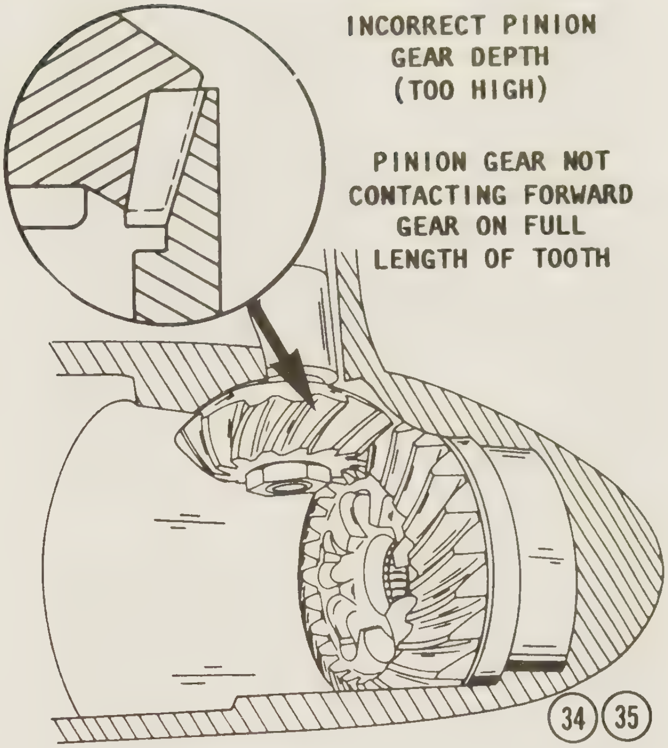
Insert the washer onto the pinion gear with the raised side facing toward the pinion gear. Install a **USED** pinion nut at **THIS** time. After the backlash checks are completed, a **NEW** nut will be installed.

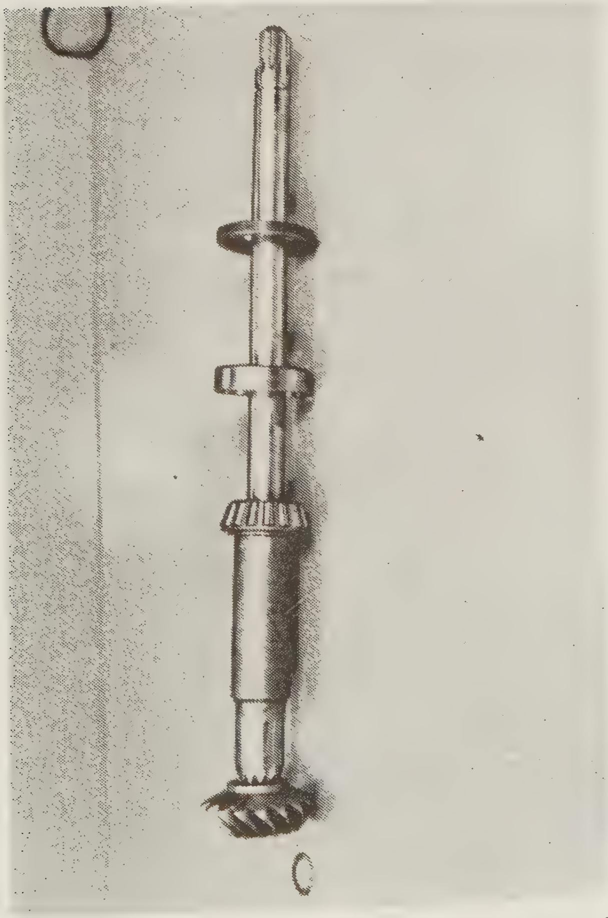
ALL UNITS

Place the shim material over the tapered bearing and down into the gear housing. The shim material was removed during the disassembly process. If the shim material was lost, destroyed or a new gear housing is being assembled, start with a shim thickness of 0.010" (0.254mm). Slide the tapered bearing race over the driveshaft and down into the gear housing. Slide the bearing retainer over the driveshaft and down into the housing, the word OFF on the retainer, must be facing up. Thread the retainer into the gear housing. Obtain bearing retainer tool 91-43506 and tighten the bearing retainer to 100 ft lbs (135.5 Nm). Slip the driveshaft adapter tool 91-34377A1 over the end of the driveshaft. Hold the pinion nut with a modified box end wrench, or socket and breaker bar. Rotate the adapter with a torque wrench and hold the pinion nut. Tighten the pinion nut to a torque value of 75 ft lbs (101.7 Nm). Insert the propeller shaft through the lower gear housing and into the forward gear.

Push inward on the propeller shaft and at the same time pull **UPWARD** on the driveshaft. While exerting this push and pull force, rotate the driveshaft **CLOCKWISE** 25 to 30 turns. This action will establish a forward and pinion gear wear pattern.







Driveshaft with associated parts arranged in the order of installation.

PINION GEAR DEPTH

GOOD WORDS

The proper amount of pinion gear depth (pinion gear engagement with the forward gear), is critical for proper operation of the lower unit. Therefore, read and **UNDERSTAND** the procedures involved in Steps 34 thru 38 before attempting any change in the shim material.

Two methods are available to properly shim the lower unit. The first method involves shimming and checking the backlash before the unit is assembled.

The second method is the factory approved procedure which involves assembling the unit; taking the required clearance measurement; and then disassembling the unit if necessary, in order to change the amount of shim material installed. This second method requires the use of special tools, while the alternate procedure can be accomplished using standard tools or modified standard tools.

Two tasks are necessary to properly shim the lower unit. First, the pinion gear must be shimmed to the correct depth. Secondly, the forward gear must be shimmed to the pinion gear for proper backlash.

The reverse gear does not require shimming. A thrust washer is used to absorb backlash.

TWO SETS OF SHIMMING PROCEDURES

Procedures are outlined in the following pages as follows:

- **a-** Shim the pinion gear without the use of special tools -- Steps 34 thru 41.
- **b-** Shim the pinion gear using special factory tools -- Steps 42 thru 48.

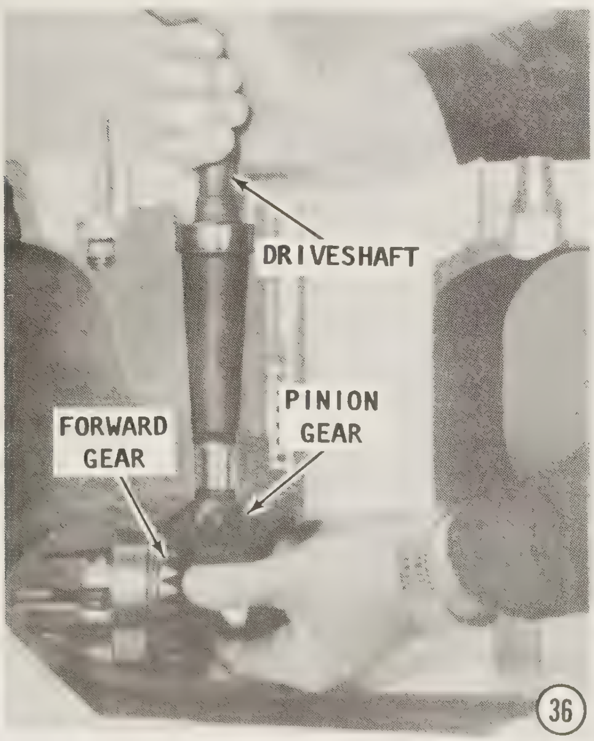
Decide how the shimming procedures are to be performed, and then move to the appropriate steps.

Pinion Gear Depth Without Special Tools

34- No tools or physical work is involved in this step. However, it is an important task toward the successful completion of the work.

Check the illustrations numbered 34 and 35 at the top of the previous page. Notice the difference between the correct pinion gear depth drawing on the left and the incorrect drawing on the right. Secure the services of an assistant, if possible, and move slowly and deliberately through each step following the listed instructions carefully.

35- Grasp the driveshaft and **PULL UP**. At the same time, check the pinion gear tooth engagement with the forward gear teeth to be sure contact is made the full length of the tooth. This check can be accomplished by using a flashlight and looking through the gear housing opening. Perhaps it would be helpful to have an assistant pull up on the driveshaft while the check is made.



Refer to the pinion gear and forward gear backlash adjustment following the next step.

36- Continue to hold the driveshaft with a strain in the **UP** direction. Reach into the bearing carrier cavity with your other hand and hook the forward gear with a couple fingers. Pull on the forward gear and rock it lightly back-and-forth. The amount of free "play" between the gear teeth is considered the gear backlash. Check the Specifications in the Appendix for the proper backlash allowed for the unit being serviced.

If the backlash appears to be correct, proceed directly to Step 41.

If the backlash is not within the Specification limits, proceed to make changes in the shim material according to the instructions outlined in the following steps.

PINION GEAR AND FORWARD GEAR BACKLASH ADJUSTMENT

The following procedures are to be performed for proper pinion gear and backlash adjustments.

If the pinion gear depth or the forward gear backlash is incorrect, follow the shimming procedures -- presented earlier in this section -- under the heading for the specific condition discovered.

Shim Material and Backlash

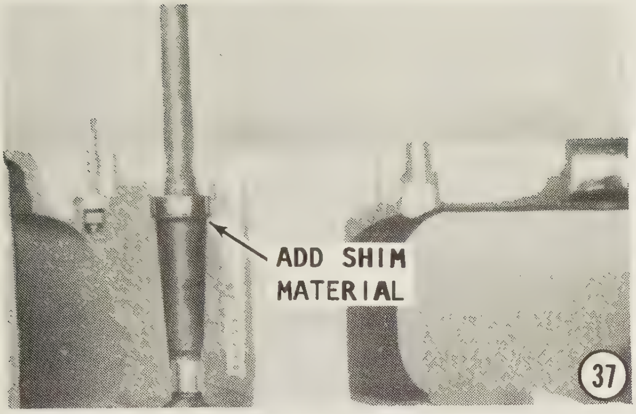
Adding or removing shim material will affect the forward gear and the reverse gear as follows:

Forward gear -- adding shim material **DECREASES** backlash.

Forward gear -- removing shim material **INCREASES BACKLASH**

Pinion Gear Depth Too Deep but Backlash LESS than Specifications

37- Remove the driveshaft, tapered bearing race if used, and the pinion gear. Add shim material to obtain the correct pinion gear depth. For each 0.001" (0.025 mm) of shim material added, the forward



gear backlash will increase approximately 0.0015" (0.038 mm).

Assemble the parts and again check the pinion depth and forward gear backlash.

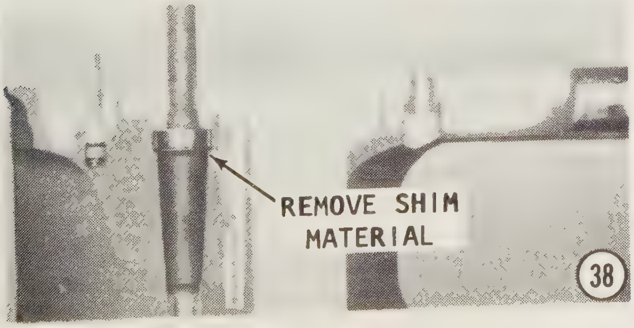
Pinion Gear Depth Too Shallow and Backlash LESS than Specifications

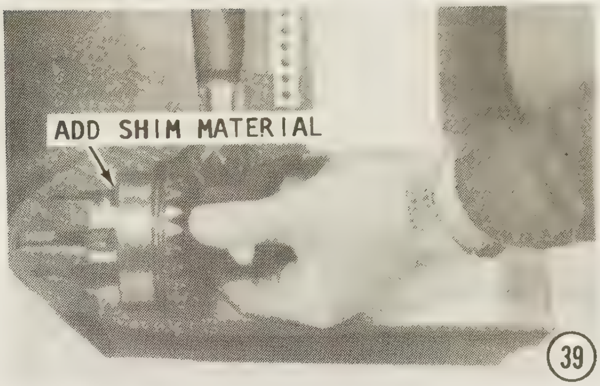
38- Remove the driveshaft, tapered bearing race, if one is used, and the pinion gear. Remove shim material to correct the pinion gear depth. Remove the forward gear and the forward gear bearing race. Remove an **EQUAL** amount of shim material from the forward gear, plus an additional amount to increase the forward gear backlash to the amount given in the Specifications. The forward gear backlash will increase approximately 0.0015" (0.038mm) for each 0.001" (0.025mm) of shim material removed from in front of the forward gear bearing.

Assemble the parts and again check the pinion gear depth and the backlash.

Pinion Gear Depth Is Correct but Forward Gear Backlash is Excessive

39- Remove the driveshaft and the pinion gear. Remove the forward gear and the forward bearing race. Add shim material to reduce the forward gear backlash. Adding 0.001" (0.025 mm) shim material will





decrease the gear backlash by approximately 0.0015" (0.038 mm). Assemble the parts and again check the forward gear backlash.

Pinion Gear Depth Is Correct but Backlash Less than Specifications

40- Remove the driveshaft and the pinion gear. Remove the forward gear and forward gear bearing race. Remove shim material to increase the gear backlash to specification. Removal of 0.001" (0.025 mm) shim material will increase the gear backlash approximately 0.0015" (0.038 mm).

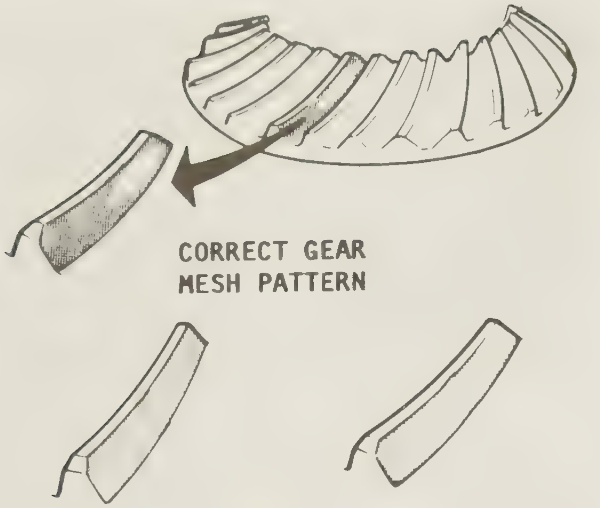
Pinion Gear and Backlash Correct

Once the proper amount of backlash and the pinion gear depth is satisfactory, check the gear mesh pattern.

41- With the unit still assembled, rotate the driveshaft **CLOCKWISE** approximately 6 to 8 complete revolutions.

Now, disassemble the unit and compare the pattern made on the gear teeth with the accompanying illustration. The pattern should almost be oval on the drive side and be positioned about halfway up the gear teeth.

If the pattern appears to be satisfactory, clean the dye or powder from the gear teeth and assemble the unit one final time. **BE SURE** to install a **NEW** nut on the pinion gear.



A normal gear wear pattern, as shown in the upper part of the illustration, will be centered on the tooth and will not extend over either end of the tooth. 41

If the pattern does **NOT** appear to be satisfactory, add or remove shim material, as required. Adding or removing shim material will move the gear pattern toward or away from the center of the teeth.

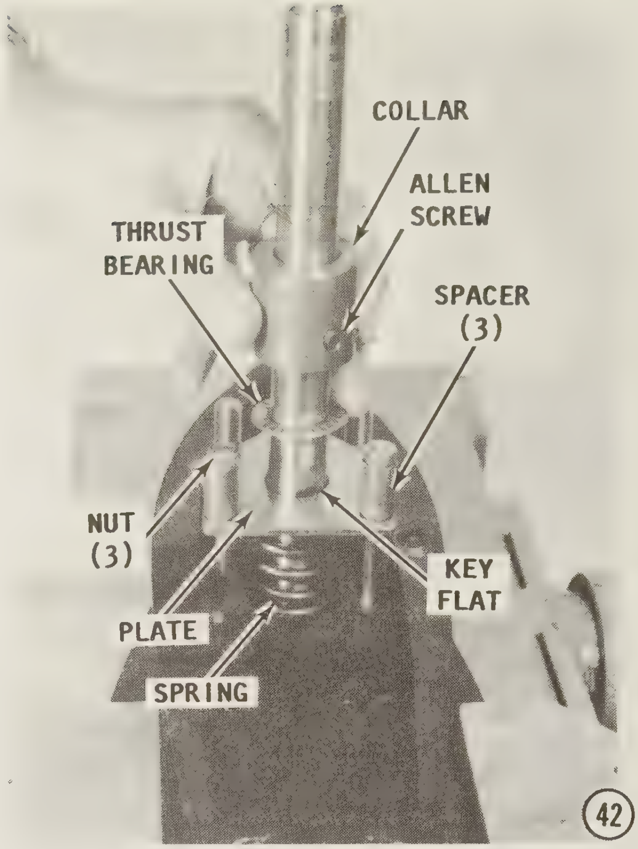
SHIMMING E-Z SHIFT USING SPECIAL TOOLS

Pinion Gear Shimming

42- If servicing a 1990 E-Z shift unit, obtain special pre-load tool P/N C-91-44307A1. If servicing a 1991 and on E-Z-shift unit, obtain special pre-load tool P/N C-91-14311A1. The special tool consists of a spring that will seat on top of the driveshaft retaining nut; a plate to fit over the driveshaft; three water pump studs; three nuts for the pump studs; a thrust bearing to ride on top of the plate; and a collar with an Allen screw to slide down the driveshaft. The Allen screw will bear on the flat on the driveshaft.

Install the spring, plate, spacers, and nuts of the tool as described and shown. One of the nuts takes a 1/2" wrench and the other two nuts a 7/16" wrench. Tighten the nuts alternately and evenly -- moving the plate down the driveshaft as the spring is compressed. Continue tightening the nuts until the 1/2" nut "bottoms out" (all the threads on the stud are used). Check to be sure the plate is fairly level with the surface of the lower unit.

Slide the thrust bearing down the driveshaft and onto the surface of the plate. The thrust



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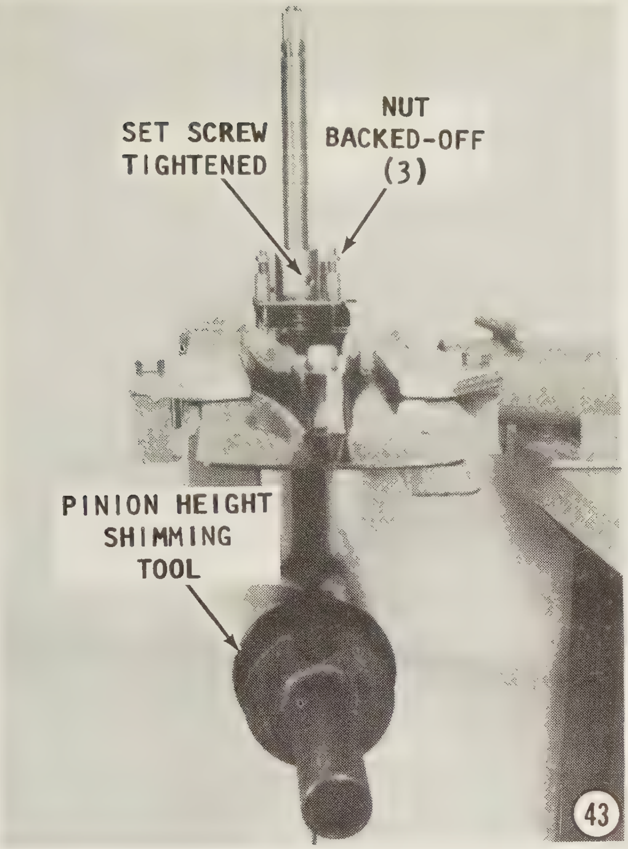
bearing may be installed with either side facing down. Check to be sure the Allen set screw in the collar is backed out to allow the collar to slide down the driveshaft. Move the collar down the driveshaft with the Allen screw end going down first, as shown and positioned to allow the Allen set screw to bear onto the water pump impeller key flat.

43- Tighten the Allen set screw securely, and then back-off the three nuts on the water pump studs. The driveshaft has now been forced **UP** placing an **UPWARD** load on the driveshaft bearing.

If servicing a 1990 unit, insert pinion gear shimming tool P/N C-91-74776 over the propeller shaft and into the housing. If servicing a 1991 and ON unit, insert tool P/N C-91-12349A2. The design of this tool will allow the flat portion of the front of the gauge to clear the pinion gear.

The tool is inserted all the way past the pinion gear, turn the tool until the flat on the tool is **AWAY** from the pinion gear. Now, with the tool held in this position, insert a 0.025" (0.64mm) feeler gauge between the bottom face of the pinion gear and the rounded part of the gauge. Most feeler gauges are not long enough to make this measurement properly. However, a suitable gauge can be made by grinding the



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teeth off a hacksaw blade and then using it to take the clearance measurement.

If the clearance is over 0.025" (0.64mm), **ADD** shim material under the bearing cup. Leave the preload shimming tool installed for forward and reverse gear shimming procedures.

44- Install the carrier shim material, which was tagged and wired together during disassembling. Install a **NEW O**-ring seal on the carrier between the thrust washer and the carrier housing. Coat the surfaces of the **O**-ring seal and carrier with anti-corrosion grease. Insert the carrier assembly.

45- Insert the bearing carrier-to-gear housing alignment key. If the housing has two

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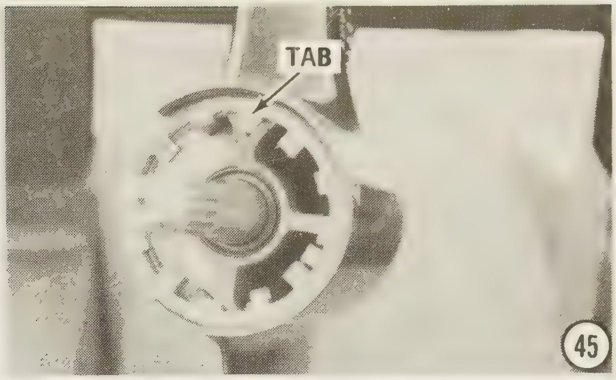

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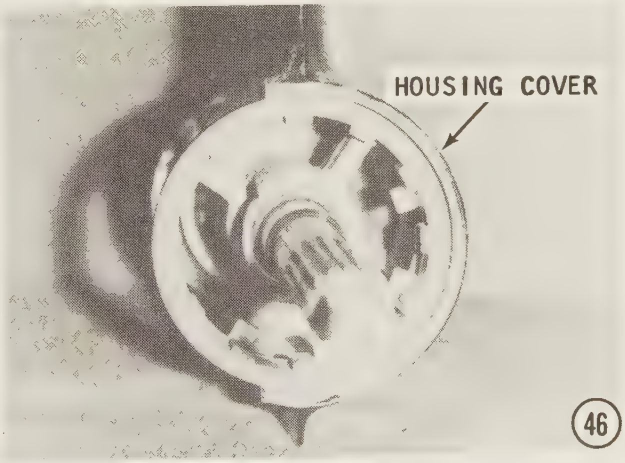
notches, use the top notch. Install the bearing carrier retainer tabbed washer, with the **V**-tab aligned with the **V**-notch on the bearing carrier.

46- Thread the gear housing cover into place **BY HAND** to prevent cross-threading. Tighten it a couple of turns by hand. Use bearing carrier wrench P/N C-91-61069 and tighten the cover to a torque value of 210 ft lbs (284.7Nm). **DO NOT** secure the tabbed washer at this time. The tab is not secured until **AFTER** the forward and reverse gear backlash has been adjusted.



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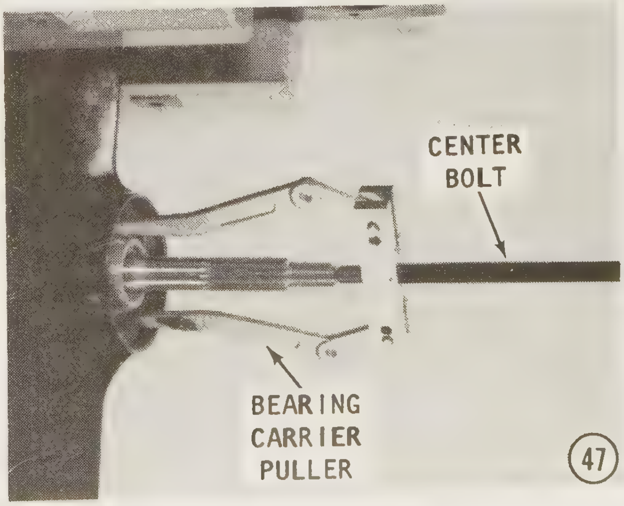

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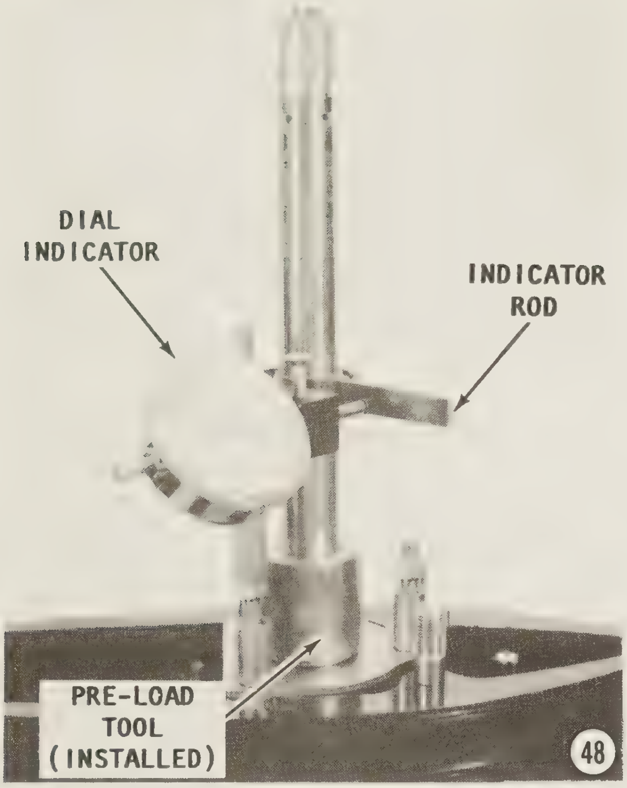
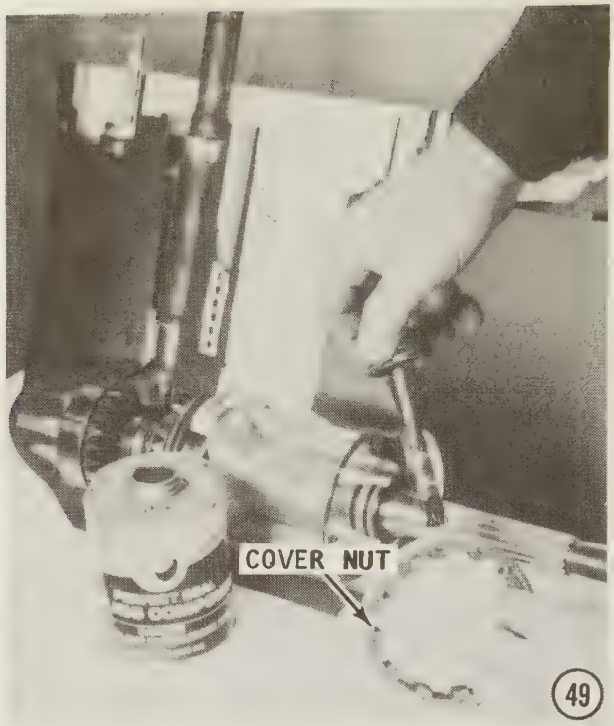




END SHIMMING PROCEDURES

Shimming Forward Gear To Correct Backlash

47- Install bearing carrier puller with the arms of the puller on the carrier and the center bolt on the end of the propeller shaft. Tighten the puller center bolt to a torque value to 45 in lbs (5Nm). This action places a preload on the forward gear, pushing the forward gear into the forward gear bearing. Rotate the driveshaft about three full revolutions, and then recheck the torque value on the center puller bolt.

48- Attach the backlash dial indicator rod P/N C-91-58222A1 to the driveshaft. Position the dial indicator shaft to the line marked **"I"** on the dial indicator rod for a pinion gear-to-forward gear ratio of 1.87:1 (15 teeth on the pinion gear).

Use the line marked **"II"** on the indicator rod for pinion gear-to-forward gear ratio of 2:1 (14 teeth on the pinion gear). Rotate the driveshaft back-and-forth and observe movement of the dial indicator. Total movement is the forward gear backlash. Check the listings in the Appendix for proper amount of backlash permissible for the unit being serviced. If the backlash is too high, **ADD** shim material from behind the forward gear bearing race. For each 0.003" (0.076mm) of backlash, add or remove 0.002" (0.051mm) shim material.

ASSEMBLING CONTINUES

49- **AFTER** correcting the forward gear backlash, **REMOVE** the bearing carrier assembly and clean it of all lubricant used during assembling. After the assembly is clean, apply a liberal coating of Perfect Seal to the outer diameters of the carrier which contact the gear housing. **DO NOT** allow any sealer to enter the ball bearing or the reverse gear. Coat the threads of the retainer with the sealer, and then thread the retainer on by **HAND**, to prevent any possibility of cross-threading.

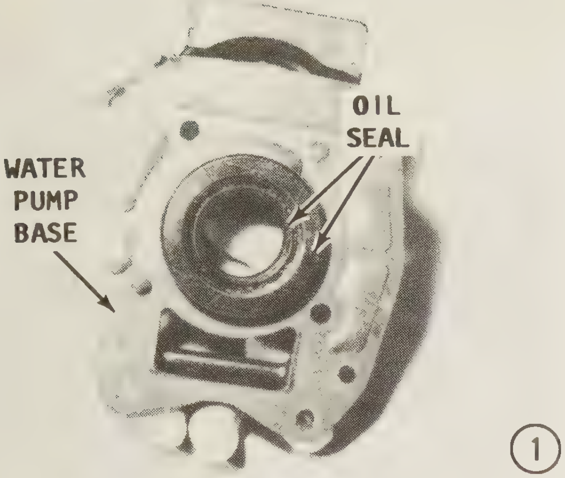
Tighten the gear housing cover to the required torque value. Bend one of the tabs on the locking washer into one of the slots in the cover.

9-7 WATER PUMP ASSEMBLING AND INSTALLATION

Models 135hp Thru 200hp

FIRST, GOOD WORDS

If the two oil seals were not removed during disassembling, skip this step and proceed directly to Step 2. If the two oil seals were removed in Step 6 of disassembly, proceed with Step 1.



1- Obtain Oil Seal Drive P/N C-91-13949, Loctite Grade "A" (271), and Quicksilver Needle Bearing Assembly Lubricant P/N C-92-42649A-1, or appropriate substitutes.

Apply Loctite to the outer circumference and pack the lip of the two oil seals to be installed with lubricant. Slide the first seal, with the seal lip facing away from the tool, onto the longer shoulder side of the installation tool. Support the water pump base in an arbor press and press in the seal until the shoulder of the tool "bottoms" against the pump base. If working without the special tool, **CAREFULLY** and **SQUARELY** tap in the seal until the seal seats inside the base.

Slide the second seal, with the seal lip facing toward the tool, onto the shorter shoulder side of the installation tool. Install this second seal in the same manner as the first.

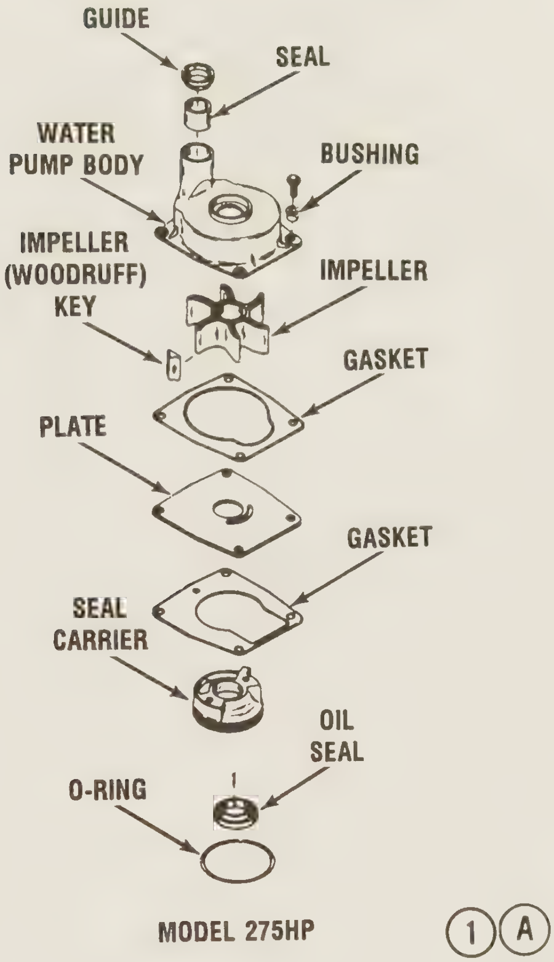
Water Pump Installation Models 225 and 275hp

GOOD WORDS

If the two oil seals were not removed during disassembling, skip this step and proceed directly to Step 2. If the two seals in the carrier for Model 225hp or one seal in the carrier for Model 275hp were removed, install the new seal/s as outlined in Steps 1A or 1B.

Model 275hp

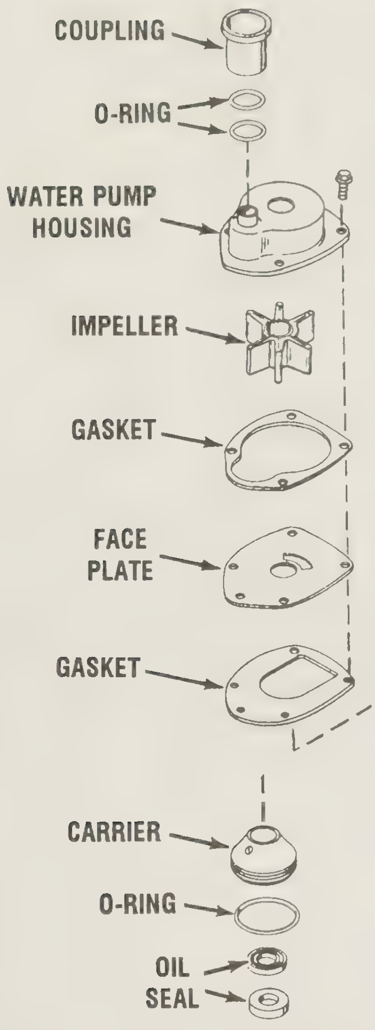
1A- Apply a coating of Loctite 271 to the outside diameter of the seal. Place the seal onto the carrier with the lip of the seal facing **UP**. Using a deep socket or mandrel the same diameter as the seal, tap the seal flush with the top of the carrier. Lubricate the **O**-ring with bearing assembly lubricant and install the **O**-ring around the seal carrier.



Slide the seal carrier down the driveshaft and into the lower unit housing. **BE SURE** the seal carrier is flush with the driveshaft bearing retaining nut. Apply a small amount of silicone sealant to the ends of the divider plate and install the plate into the housing.

Model 225hp

1B- Place the first seal, with the seal lip facing **UP** into the bore of the carrier. Press the seal into the carrier with a mandrel or deep socket. Place the second seal into the carrier with the lip of the seal facing **DOWN**, (seals should be back-to-back). Press the seal into the carrier with a mandrel or deep socket until it contacts the other seal. Lubricate the **O**-ring with bearing assembly lubricant and install the **O**-ring around the carrier. Slide the carrier down the driveshaft and into the lower unit housing. **BE SURE** the carrier is flush with the driveshaft bearing retaining nut. Install the filler block into the housing behind the driveshaft.



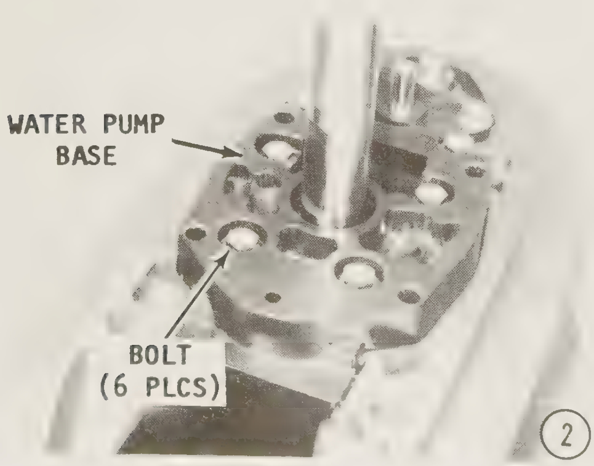
MODEL 225HP

1 B

ALL MODELS

2- Place a new gasket in place on the lower unit. Slide the water pump base down over the driveshaft. Tap the base down lightly to seat it over the gasket.

3- Slide the gasket and then the outer plate down the driveshaft.



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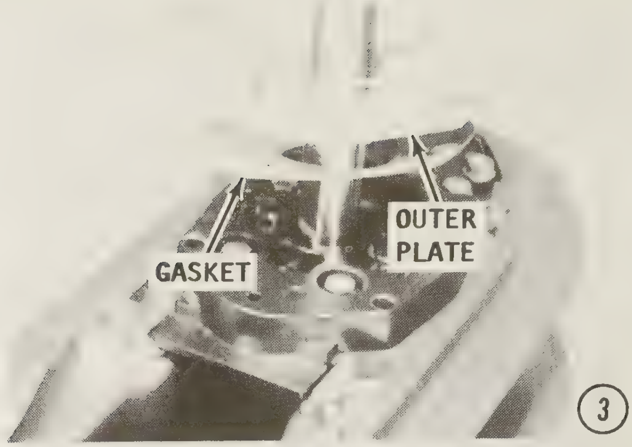

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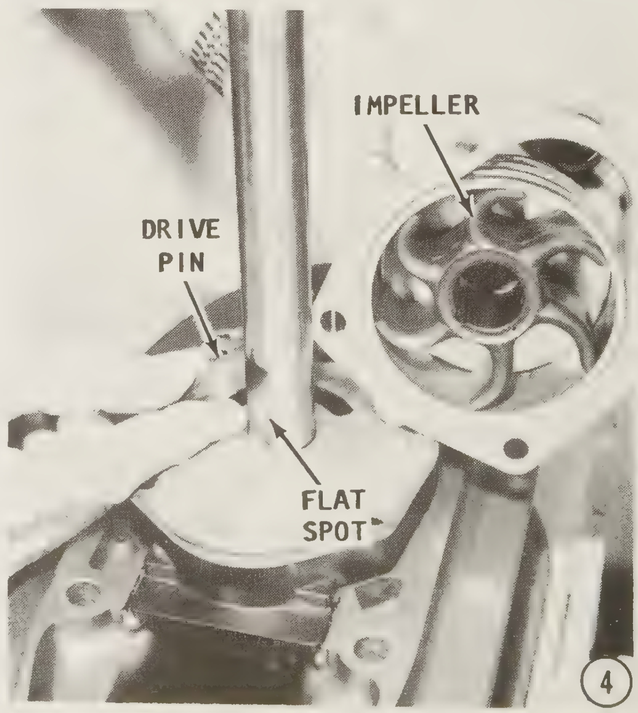
4- Coat the impeller drive pin area of the driveshaft with Water Resistant Multipurpose Lubricant. Position the impeller drive pin on the flat spot on the driveshaft. The lubricant will hold the pin in place. Slide a **NEW** impeller down the driveshaft and over the drive pin.

GOOD WORDS

If at all possible, **ALWAYS** install a **NEW** water pump impeller. If the old impeller must be installed, install the impeller in the **SAME POSITION** to allow the vanes to rotate in the same direction as the original installation. If the impeller is installed causing the vanes to rotate in the opposite direction, premature impeller failure of the impeller will surely occur.

5- Apply a thin coating of Water Resistant Multi-purpose lubricant to the inside diameter of the water pump cover. Apply



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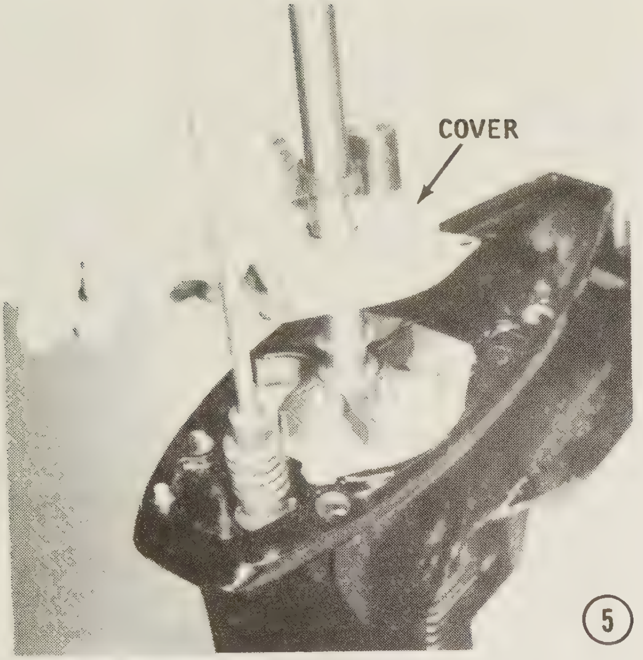
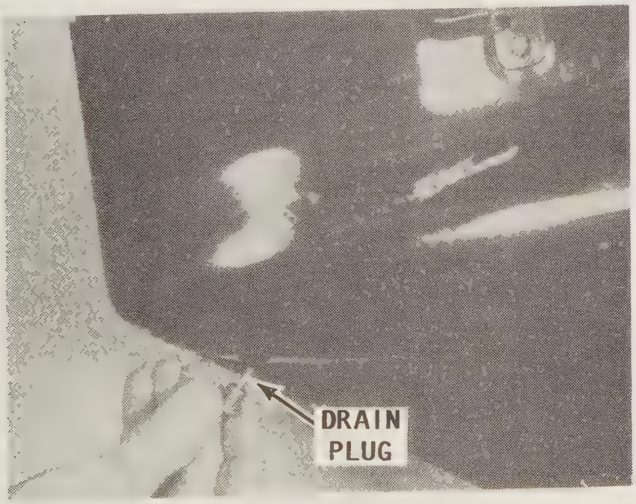


Loctite "A" (271) to the threads of the four securing bolts. Slide the cover down the driveshaft. Rotate the shaft **CLOCKWISE** and at the same time push down on the pump cover to ease entry of the impeller into the cover.

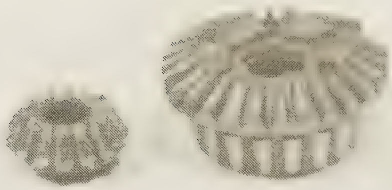
Install the water pump cover retaining bolts, washer, and isolators. Tighten the bolts to a torque value of 60 in lbs (6.8Nm).

Slide the sealing ring down the driveshaft onto the top of the water pump cover.

Apply a coating of Water Resistant Multipurpose lubricant around the inside diameter of the water tube grommet as an aid in later assembly to the water tube.



Installing the drain plug with an integral magnet to catch and hold metal particles in the lubricant. While oil is draining, catch and run some between your fingers for any evidence of metal particles.



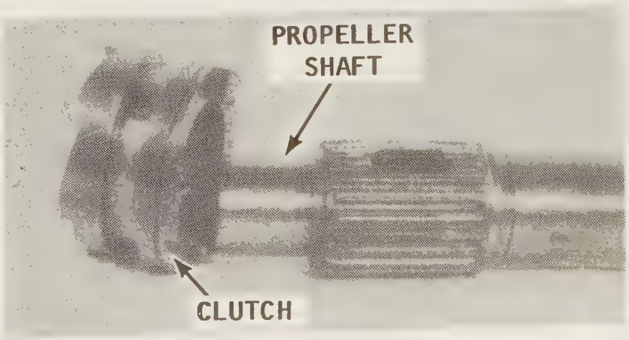
The teeth of the forward or reverse gear (right) and of the pinion gear (left), should be closely inspected to ensure satisfactory service.

9-8 CLEANING AND INSPECTING ALL LOWER UNITS

A substantial contribution to a successful overhaul job on the lower unit can be directly attributed to the cleaning and inspecting of the various parts. Close attention to detail is the password. Remember, if only one bearing in a set is defective -- the entire set must be replaced. Good shop practice dictates all **O**-rings and seals should be discarded, once they have been removed.

Clean all water pump parts with solvent, and then dry them with compressed air. Inspect the water pump cover and base for cracks and distortion, possibly caused from overheating. Inspect the face plate and water pump insert for grooves and/or rough surfaces. If possible, **ALWAYS** install a new water pump impeller while the lower unit is disassembled. A new impeller will ensure extended satisfactory service and give "peace of mind" to the owner. If the old impeller must be returned to service, **NEVER** install it in reverse to the original direction of rotation. Installation in reverse will cause premature impeller failure.

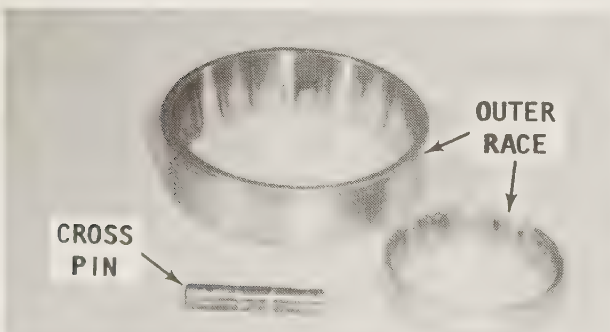
Inspect the impeller side seal surfaces and the ends of the impeller blades for cracks, tears, and wear. Check for a glazed



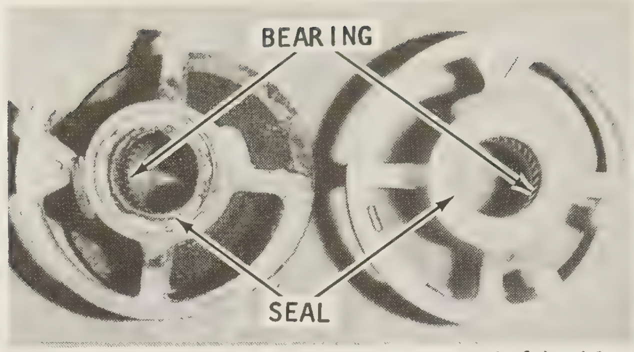
The clutch "dog" and matching splines on the propeller shaft should be closely inspected.

A rusted and corroded gear. Water was allowed to enter the lower unit through a bad seal and cause this damage to the gear and other expensive parts.

A new needle bearing (left), alongside a used needle bearing set after the bearing was removed using the "bigger hammer" method.



Grooves on the cross pin or marked wear patterns on the outer roller bearing races are evidence of premature failure of these and possibly associated parts.



Comparison of a worn bearing carrier (left) with a new one (right).

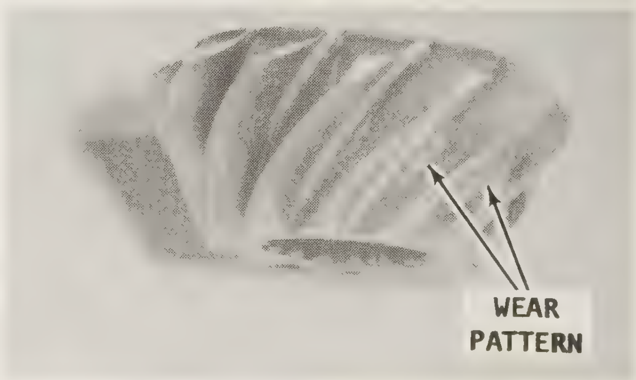
or melted appearance, caused from operating without sufficient water. If any question exists, and as previously stated, install a new impeller if at all possible.

Clean all bearings with solvent, dry them with compressed air, and inspect them carefully. Be sure there is no water in the air line. Direct the air stream through the bearing. **NEVER** spin a bearing with compressed air. Such action is highly dangerous and may cause the bearing to score from lack of lubrication. After the bearings are clean and dry, lubricate them with Quicksilver Formula 50-D lubricant or equivalent. Do not lubricate tapered bearing cups until after they have been inspected.

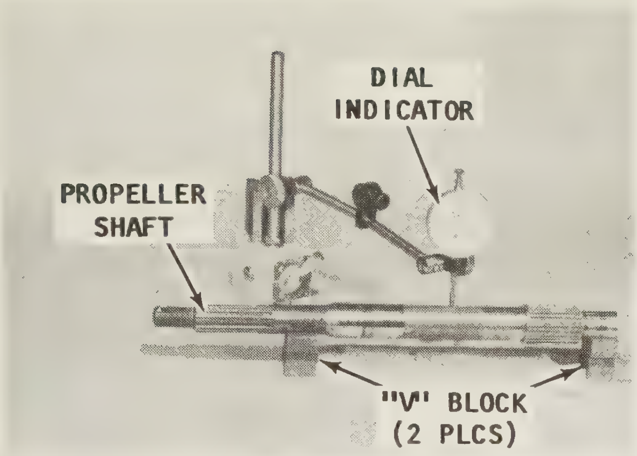
Inspect all ball bearings for roughness, catches, and bearing race side wear. Hold the outer race, and work the inner bearing race in-and-out, to check for side wear.

Determine the condition of tapered bearing rollers and inner bearing race, by inspecting the bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles, and discoloration caused from overheating. **ALWAYS** replace tapered roller bearings as a set.

Inspect the bearing surface of the shaft roller bearing support. Check the shaft



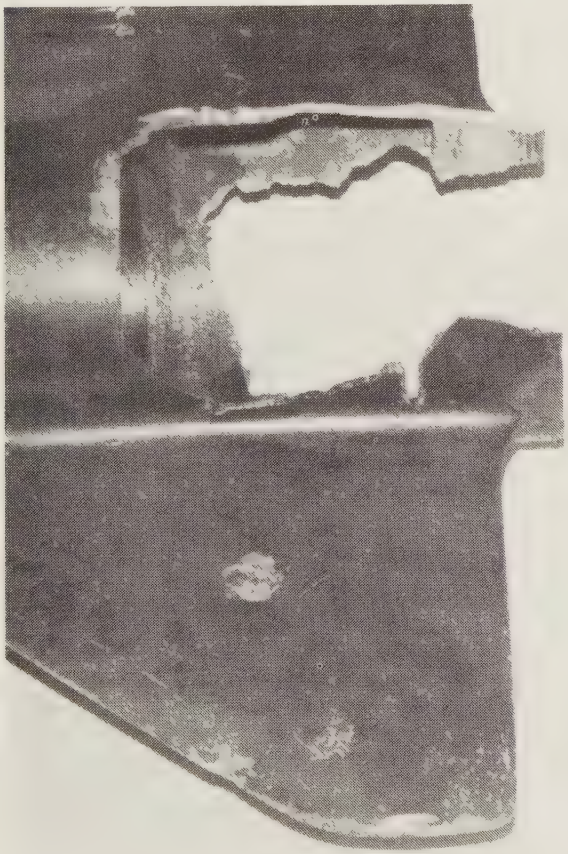
Unacceptable pinion gear wear pattern, probably caused by inadequate lubrication in the lower unit.



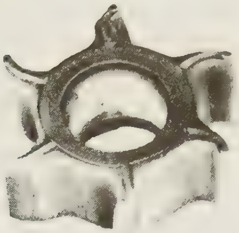
Using a dial indicator and two "V" blocks to measure the propeller shaft runout, as described in the text.

surface for pitting, scoring, grooving, imbedded particles, uneven wear and discoloration caused from overheating. The shaft and bearing must be replaced as a set if either is unfit for continued service.

Inspect the sliding clutch of the propeller shaft. Check the reverse gear side clutch "dogs". If the "dogs" are rounded one of three causes may be to blame.

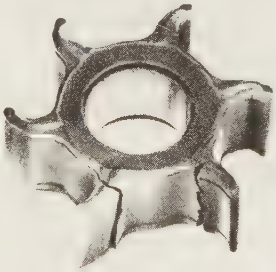


This lower unit housing was destroyed because the bearing carrier was "frozen" so badly drastic action was required. Even so, all working components inside the unit were saved for further service.



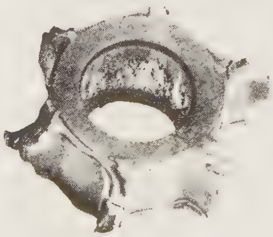
After 60 seconds at 1500 rpm.

After 90 seconds at 1500 rpm.



After 30 seconds at 2000 rpm.

After 45 seconds at 2000 rpm.



After 60 seconds at 2000 rpm

Water pump impeller damage caused by the powerhead running at various speeds for short periods without water circulating through the pump.

a- Improper shift cable adjustment.

b- Running engine at too high an rpm while shifting.

c- Shifting from neutral to reverse gear too quickly.

Inspect the cam follower and replace it and the shift cam if there is any evidence of pitting, scoring, or rough surfaces.

Check the straightness of the propeller shaft with a set of V-blocks. Rotate the propeller shaft on the blocks and at the same observe the propeller shaft splined area for a bend. Inspect the seal surfaces, the area of the shaft where the bearing carrier oil seals make contact. If any type of groove is discovered in this area the shaft should be replaced. Inspect the propeller shaft spline area for corrosion damage or wear.

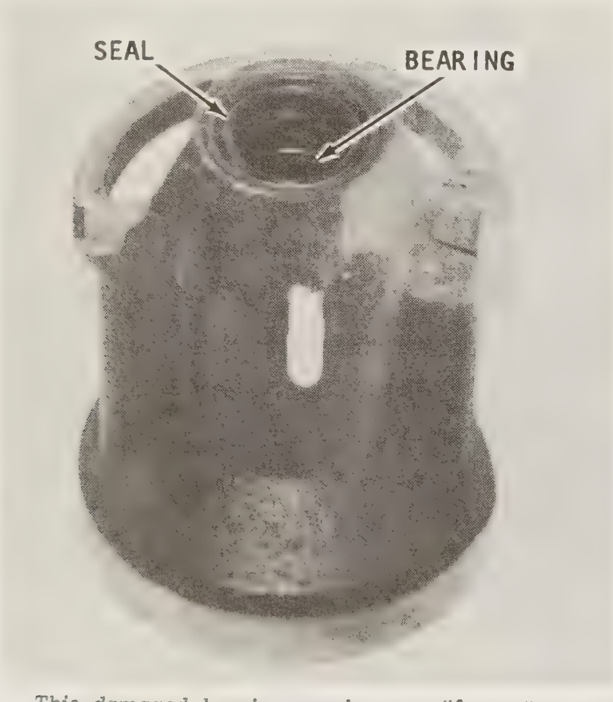
Inspect the propeller shaft roller bearing surfaces for pitting, rust marks, uneven wear, imbedded metal particles or signs of overheating caused by lack of adequate lubrication.

Good shop practice requires installation of new O-rings and oil seals **REGARDLESS** of their appearance.

Clean the bearing carrier, pinion gear, drive gear clutch spring, and the propeller shaft with solvent. Dry the cleaned parts with compressed air.

Check the pinion gear and the drive gear for abnormal wear. Apply a coating of light-weight oil to the roller bearing. Rotate the bearing and check for cracks or catches.

Inspect the propeller shaft oil seal surface to be sure it is not pitted, grooved, or scratched. Inspect the roller bearing contact surface on the propeller shaft for pitting, grooves, scoring, uneven wear, imbedded metal particles, and discoloration caused from overheating.



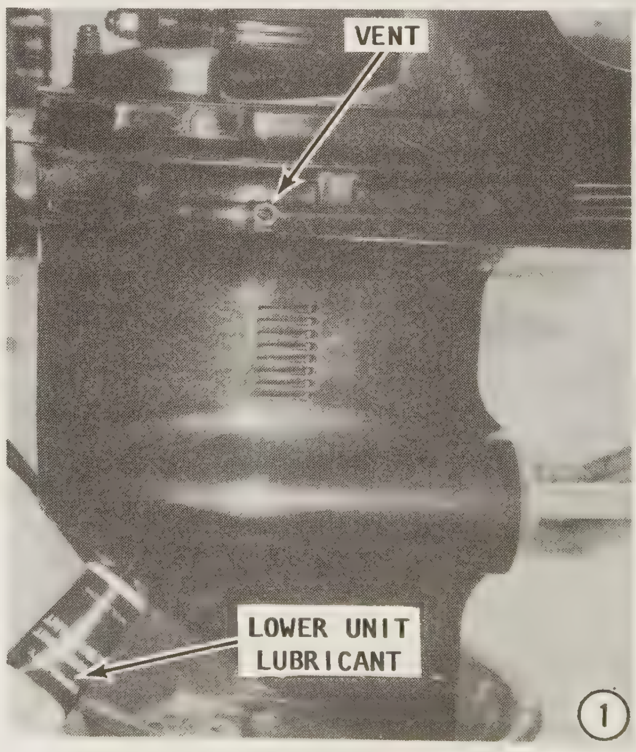
This damaged bearing carrier was "frozen" in the lower unit and destroyed during the removal process.

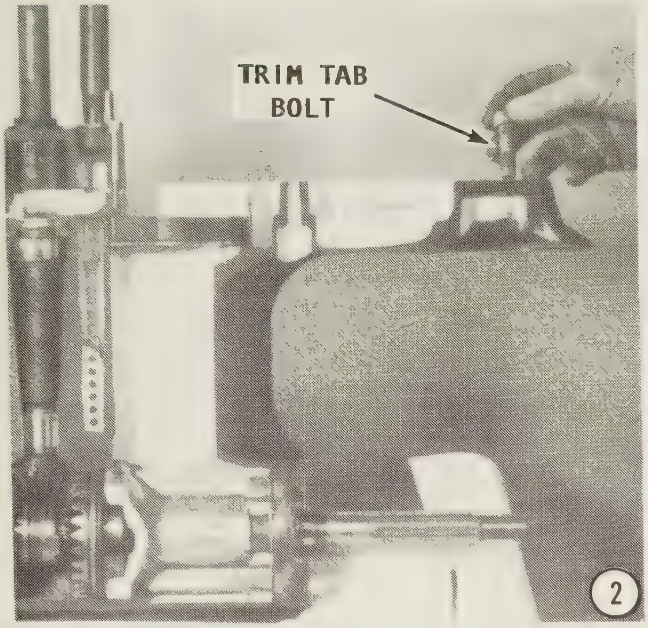
9-9 LOWER UNIT INSTALLATION

Filling Lower Unit

1- Always fill the lower unit with lubricant and check for leaks **BEFORE** installing the unit to the driveshaft housing.

Take time to remove any old gasket material from the **FILL** and **VENT** recesses and from the screws. Place the lower unit in an upright vertical position. Fill the lower unit with Super-Duty Lubricant, or equivalent, through the **FILL** opening at the bottom of the unit. **NEVER** add lubricant to the lower unit without first removing the **VENT** screw **AND** having the unit in its normal operating position -- vertical. Failure to remove the vent screw will result in air becoming trapped within the lower unit. Trapped air will not allow the proper amount of lubricant to be added.





Continue filling **SLOWLY** until the lubricant begins to escape from the **VENT** opening with no air bubbles visible. Quantity of lubricant to fill a "dry" unit is approximately 25 fl oz.

Use a **NEW** gasket and install the **VENT** screw. Slide a **NEW** gasket onto the **FILL** screw. Remove the lubricant tube and **QUICKLY** install the **FILL** screw.

Check the lower unit for leaks.

2- Install the trim tab bolt into the rear hole in the rear of the lower unit-to-exhaust housing machined surface.

3- Install the water tube guide into the water pump cover above the water tube seal.

CRITICAL WORDS

Check the lower unit to be sure it is in the proper gear as follows:

Cam-Shift unit -- **FORWARD** gear.

E-Z Shift unit -- in **NEUTRAL.**

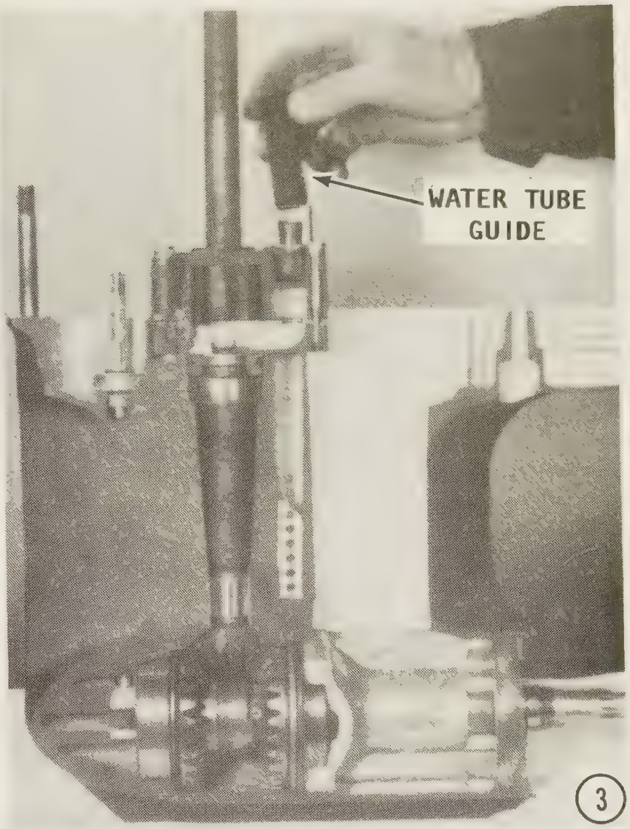
Move the upper shift shaft into the proper gear position also.

4- Align the guide block to position the rear edge of the pin with the front edge of the exhaust cover plate -- illustration 4A.

On Cam-Shift units, the forward end of the shift block **MUST** extend 1/8" (3.2mm) past the front of the rail -- illustration 4B.

Model 225hp Only

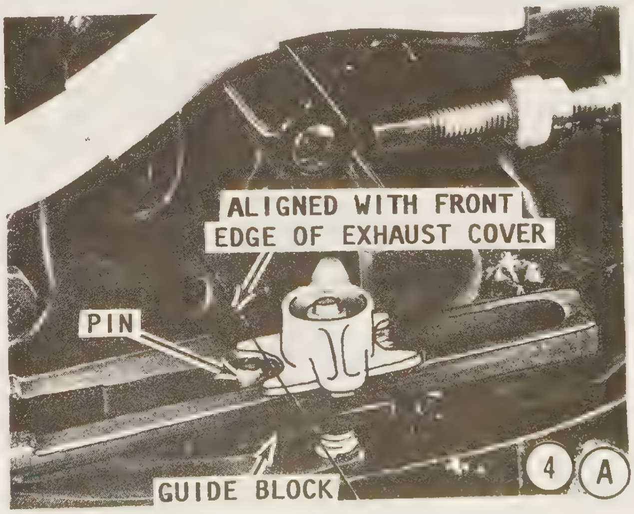
5- Install the splined nylon tube onto the upper end of the driveshaft. Slide the seal onto

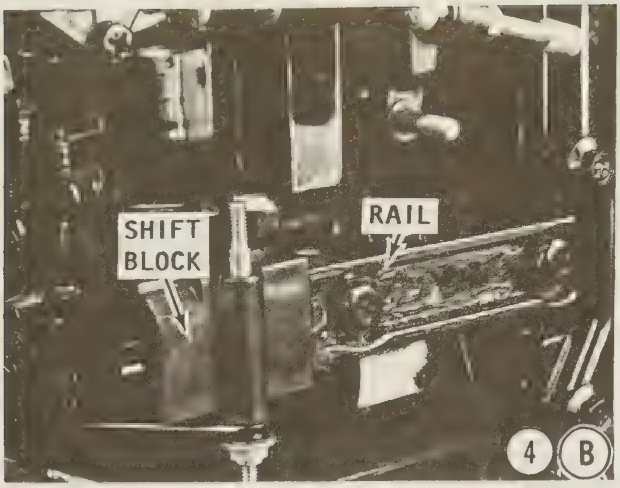


the driveshaft with the splined portion **TOWARD** the nylon tube.

All Models

6- Tilt the powerhead and intermediate housing outward, and then engage the tilt lever. Check to be sure the water tube is in position in the exhaust extension plate. Check to be sure the reverse lock push rod and the shift shaft guide block are in the correct position, as indicated above in Step 3. Apply a light coating of Multipurpose Lubricant to the driveshaft splines and to the shift shaft splines.



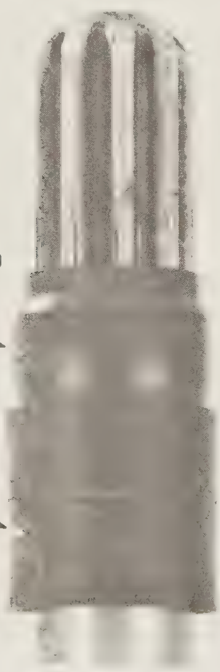


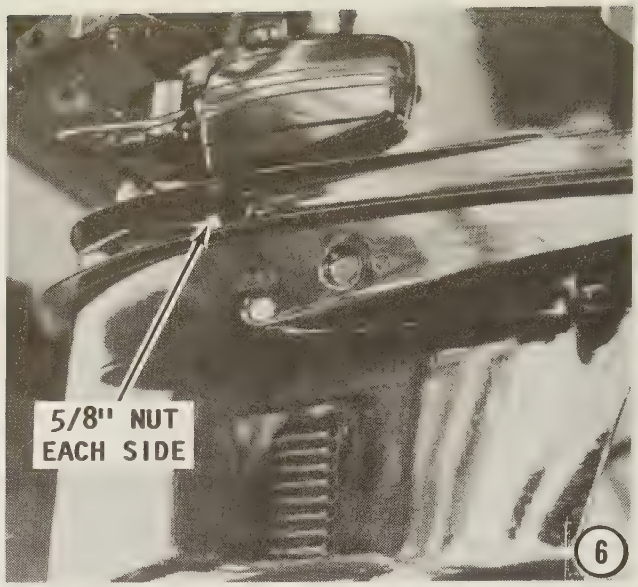
BAD NEWS

An excessive amount of lubricant on top of the driveshaft to crankshaft splines will be trapped in the clearance space. This trapped lubricant will not allow the driveshaft to fully engage with the crankshaft. As a result, when the lower unit nuts are tightened, a load will be placed on the driveshaft/crankshaft and will cause damage to either the powerhead or the lower unit or both. Therefore, any lubricant **MUST** be cleaned from the top of the driveshaft.

Secure the services of an assistant because of the lower unit weight and because several things must be done -- items guided and aligned, all at the same time.

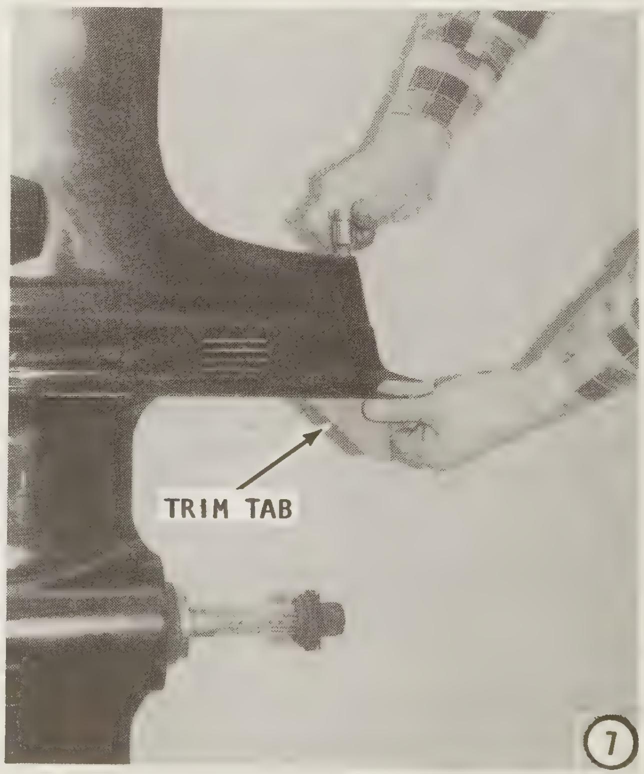
Position the lower unit under the exhaust housing with the machined surfaces parallel.

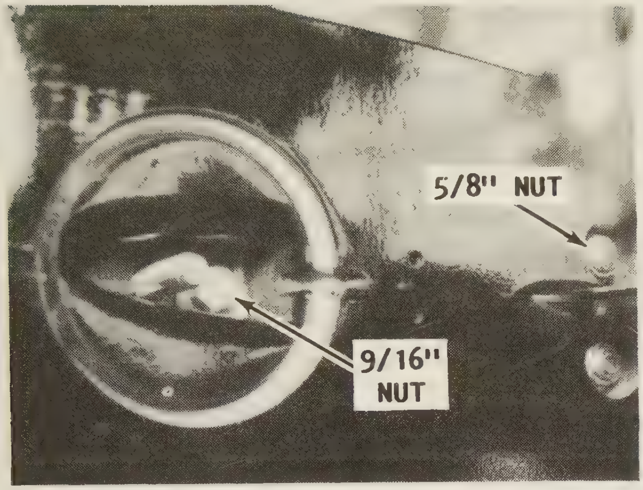




With the help of an assistant, raise the lower unit and guide the driveshaft into the exhaust housing. Almost at the same time guide the water tube into the water guide tube with your fingers or with a screwdriver. Route the speedometer hose up through the shift shaft opening.

Now, raise the lower unit further with the housing sliding up over the studs. Raise the unit as far as possible. Maintain pressure on the lower unit against the exhaust housing and at the same time slowly rotate the powerhead flywheel **CLOCKWISE** to permit the driveshaft





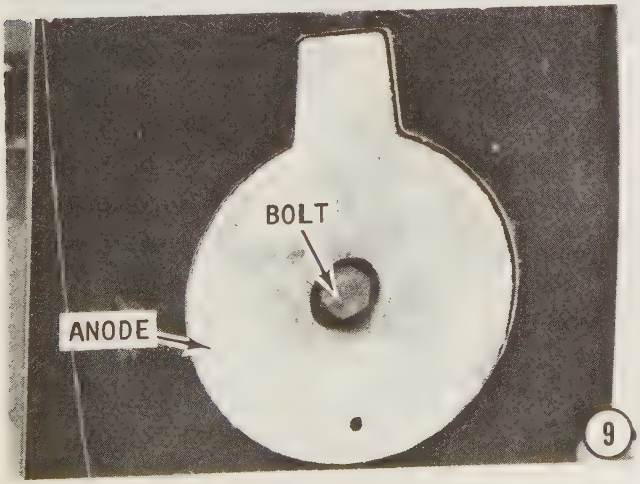
The 9/16" nut in the recess is covered by the trim tab. A reference mark enscribed on the trim tab and on the anti-cavitation plate will allow the trim tab to be installed back at the same angle from which it was removed.

splines index with the crankshaft splines. When the splines are aligned and index with each other, the two units may be moved closer together.

Slide the flat washers onto the studs on both sides of the exhaust housing. Start the nuts onto the studs and bring them up **FINGERTIGHT**. Check the upper shift shaft entry into the lower shift shaft by observing the position of the shift shaft at the exhaust extension plate bushing. If the upper and lower shift shafts are not aligned, the upper shaft will be pushed upward as the lower unit is tightened against the exhaust housing.

Shift Shaft Alignment

To correct the entry of the upper shift shaft into the lower shift shaft, place a punch against the upper shift shaft, and then strike the punch with a hammer to help align the shaft. **AVOID** excessive force. If necessary, realign the shafts.



After the shift shafts are aligned and the driveshaft splines have indexed properly with the crankshaft splines, close the gap between the lower unit and the exhaust housing until the two machined surfaces make contact. Now, hold the two units in contact with one hand and check the shift operation with the other hand. Shift into **FORWARD** gear; the propeller shaft should **NOT** rotate counterclockwise. Shift into **NEUTRAL**. The propeller shaft should be free to rotate in either direction. Shift into **REVERSE** gear. The propeller shaft should be free to turn in either direction **ONLY** about 1/3 turn.

If the lower unit fails any of the shift tests just described, the upper and lower shift shafts are not aligned properly. Remove the lower unit and repeat this step.

After the shift operations are verified as correct, start the bolt at the rear of the lower unit inside the trim tab recess. **DO NOT** tighten the bolt at this time.

Alternately and evenly tighten the two nuts started earlier in this step. Slide the washers, and then start the nuts onto the studs at the bottom center of the anti-cavitation plate. Install the washer and nut onto the stud at the leading edge of the intermediate housing. Tighten the bolt started in the trim recess.

Tighten the 3/8"-16 nuts securing the lower unit to the intermediate housing to a torque value of 55 ft lb (75Nm).

Tighten the 7/16"-20 nuts or bolts securing the lower unit to the intermediate housing to a torque value of 65 ft lbs (88Nm).

Tighten the trim tab bolt to a torque value 25 ft lbs (34Nm).

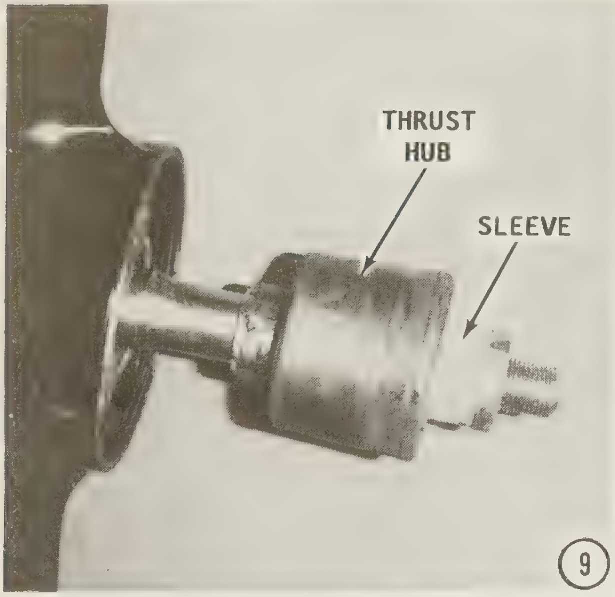
7- Install the trim tab in the same position from which it was removed. A scribe mark should have been made on the trim tab and a matching mark on the anti-cavitation plate before the trim tab was removed. These marks were to **ENSURE** the tab would be installed at the same angle, as mentioned in Step 7 -- Page 9-7 -- of the removal procedures.

Model 225hp and 275hp

8- Apply a thin coating of Loctite Grade "A" to the threads of the anode retaining bolt. Install the anode plate, and then tighten the bolt to a torque value of 15 ft lbs (20.3Nm).

GOOD WORDS

The trim tab should be positioned to enable the helmsperson to handle the boat with equal



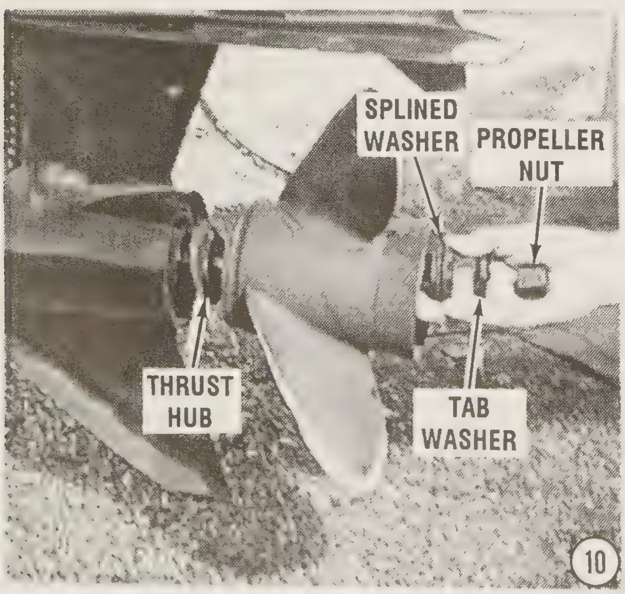
ease to starboard and port at normal cruising speed. If the boat seems to turn more easily to starboard, loosen the socket head screw and move the trim tab trailing edge to the right. Move the trailing edge of the trim tab to the left if the boat tends to turn more easily to port.

Snap the plastic cap into the trim tab bolt opening at the rear edge of the lower unit. Shift the unit into **FORWARD** gear, release the tilt lock lever and lower the outboard to the normal operating position.

Propeller Installation

SAFETY WORDS

An outboard powerhead may start very easily. Therefore, anytime the propeller is to be removed or installed check to be sure:



a- Key switch is in the **OFF** position.

b- Spark plug high tension leads are disconnected from the spark plugs.

c- Electrical leads are disconnected at the battery terminals.

9- Position the thrust hub over the propeller with the shoulder side entered into the propeller.

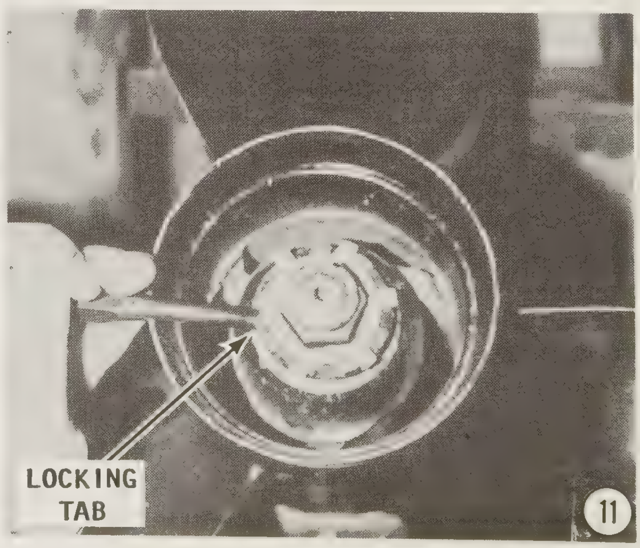
ADVICE WORDS

As an aid to removing the propeller the next time, apply a liberal coating of Perfect Seal to the propeller shaft splines.

10- Position the propeller on the propeller shaft, and then slide it up against the thrust hub taper. Slide a second splined washer onto the propeller shaft and engage the splines in the washer with the splines of the propeller shaft. Slide the tab washer onto the propeller shaft with the nut recess **TOWARD** the splined washer. Start the propeller nut onto the propeller shaft threads.

Align the tabs on the tab washer with the recessed areas of the splined washer. Place a block of wood between a propeller blade and the anti-cavitation plate to prevent the propeller shaft from rotating while the nut is being tightened. Tighten the propeller nut to a torque value of 55 ft lbs (75Nm).

11- Use a punch and hammer to bend the tabs of the tab washer into the recesses of the splined washer. Remove the block of wood. Connect the spark plug high tension leads to the spark plugs. Connect the electrical lead to the battery terminal. Mount the outboard unit in a test tank or on a boat in a body of water.



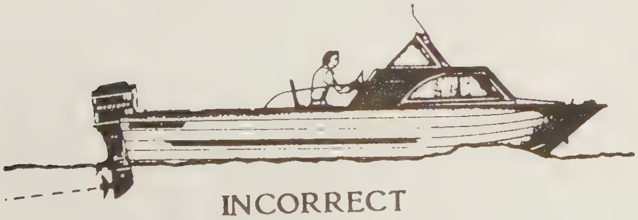
10

TRIM/TILT

10-1 INTRODUCTION

Since early days all outboard units have been equipped with some means of raising or lowering the unit for efficient operation under various load, boat design, and water conditions. The most simple method was a mechanical tilt adjustment consisting of a series of holes in the transom mounting bracket through which an adjustment pin passed through to secure the unit at the desired angle. For many years now, a more modern method, especially for the larger units, is a hydraulically operated system controlled from the helmsperson's position, or through a set of switches on the starboard side of the lower powerhead cowling.

INCORRECT
Bow too high -- trim engine down.



INCORRECT
Bow too low -- trim engine up.

CORRECT
Boat and engine properly trimmed.

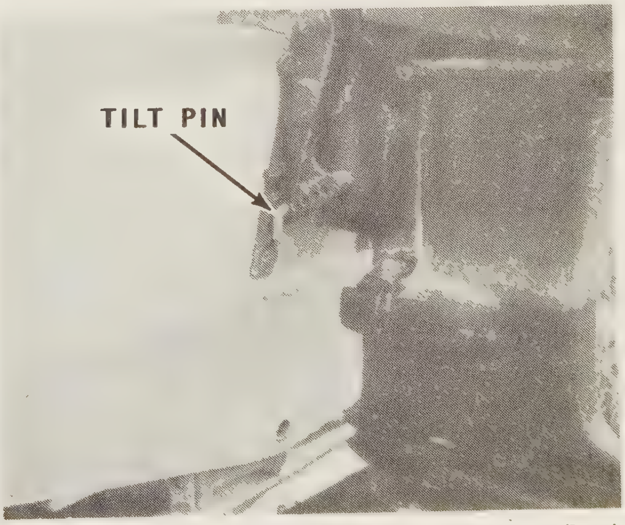
The trim position of the outboard unit directly affects the bow position and thus the boat performance.

Over the years, a single cylinder and a three cylinder hydraulic system have been used. For ease of identification the single cylinder has been designated **System "A"** and the three-cylinder as **System "B"**. The following paragraphs briefly describe these systems.

Each system has been modified slightly with engineering changes, but the general concept of operation has remained the same. Complete, detailed and illustrated procedures for each system are presented later in this chapter. When differences do occur within a system affecting procedures, the differences have been clearly identified.

Mechanical Trim Pin

A mechanical trim pin is provided to pass through a set of holes in the transom bracket to



The tilt position is adjusted by inserting the tilt pin through one of a series of holes in the transom bracket.

actually prevent the outboard unit from moving forward, but allows aft/upward movement if the unit strikes an underwater object or the unit must be raised for trailering.

Single Cylinder System "A"

The single cylinder power trim/tilt system consists of an electric motor, pump, pressurized fluid reservoir, one large trim/tilt cylinder and electrical components for operation.

The single cylinder extends very slowly through the first 20° -- considered the trim range -- and then accelerates to move the outboard to the desired tilt position for trailering or shallow water operation.

Three Cylinder System "B"

The three cylinder system incorporates two small trim cylinders and one large tilt cylinder. The trim cylinders move the outboard upward or downward very slowly through the 20° trim range. Once the maximum trim angle has been reached, the tilt cylinder continues to move the outboard upward or downward at a much faster rate.

CHAPTER ORGANIZATION

This chapter is divided into the following broad sections, with headings for specific areas of interest or work, as indicated.

10-2 Mechanical Trim Pin - All Units

10-3 Single-Cylinder Trim/Tilt Designated as System "A".
- Description and Operation
- Trailering
- Hydraulic Servicing
- Purging -- "bleeding" -- air from system
- Troubleshooting
- Pump Removal and Installation
- Cylinder Removal and Disassembling
- Cleaning and Inspecting
- Cylinder Assembling and Installation

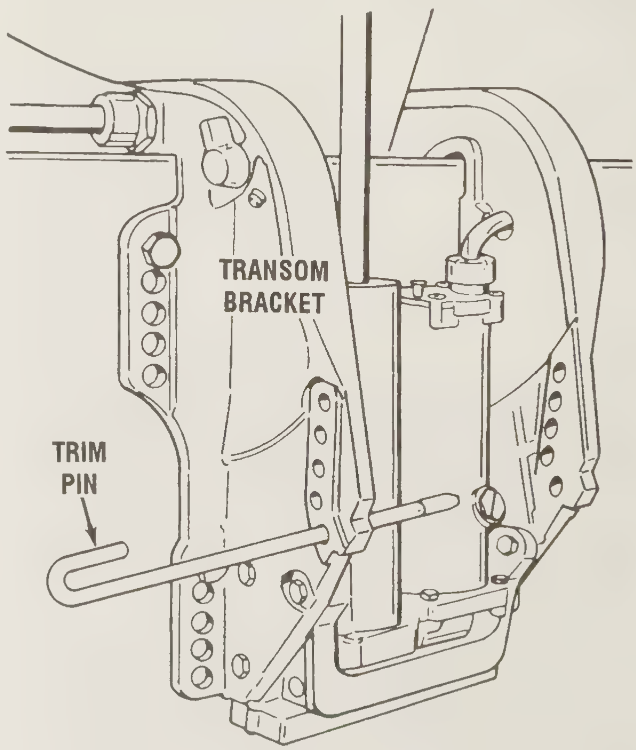
10-4 Three Cylinder Trim/Tilt System
- Description and Operation
- Trailering
- Special Instructions
- Hydraulic Bleeding
- Troubleshooting
- Removal and Disassembling
- Cleaning and Inspecting
- Assembling and Installation

10-2 MECHANICAL TRIM PIN ALL UNITS

The mechanical trim pin or bolt on the V-6 outboards covered in this manual is used to set the maximum "IN" trim angle. During high speed operation with the outboard trimmed to the full "IN" position -- no trim pin installed -- some boat and outboard combinations may experience unstable or unsafe steering conditions. To prevent the operator from accidentally trimming the outboard to the full "IN" position with the trim/tilt system, a mechanical pin or bolt is installed through the transom brackets to stop the forward movement of the outboard. However, this pin still allows the unit to swing aft and upward if it strikes an underwater object or for trailering purposes.

The initial trim angle of the lower unit is normally set by the boat manufacturer when the outboard is installed. Any changes to the trim pin or bolt setting, will require the boat to be tested at "planned" speed for any unstable steering conditions.

Performance will generally be improved if the bow is lowered during operation in rough water. The boat should **NEVER** be operated with the lower unit set at an excessively raised



Simple line drawing to depict the mechanical trim pin which is passed through matching holes in the port and starboard clamp brackets to achieve the desired trim angle, depending on the transom angle and boat load.

position. Such a trim angle will cause the boat to "porpoise", which is very dangerous in rough water. Under such conditions, the helmsperson does not have complete control at all times.

Instead of making extreme changes in the lower unit angle, it is far better to shift passengers and/or the load to obtain proper performance.

CAUTION

If the outboard unit is trimmed to the full **"IN"** trim angle -- without using the trim pin or adjustment bolt -- the steering condition will be most undesirable and could be **UNSAFE** at planing speed. Therefore, each boat must be tested for acceptable handling following outboard installation and trim adjustments.

Maximum Efficiency

In order to obtain maximum efficiency and safety from the boat and outboard unit, the trim pin must be installed in the proper position. The wide range of boat designs with their various transom angles, requires a determination be made for each outboard installation.

Actually the trim pin is only required if the boat handles improperly in the full trimmed "IN" position at wide open throttle (WOT). Usually this occurs when the transom "angle" is too large.

This section provides detailed procedures to properly install the trim pin or bolt.

Trim Pin Installation

Refer to the accompanying illustration while performing the following installation instructions.

First, operate the power trim system to move the outboard unit inward or outward until the anti-cavitation plate is parallel to the bottom of the boat. With the outboard unit in this position, notice the position of the swivel bracket in relation to the clamp bracket trim pin holes.

Next, install the trim pin, or bolt into the first full hole closer to the transom. Slide the trim pin, or bolt, through both holes on the transom plate. Close the clevis on the end of the pin to secure the pin in place. If a bolt is used as the trim pin, install a flat washer over the threaded end of the bolt. Install and tighten the nut until there is no free "play" in the bolt.

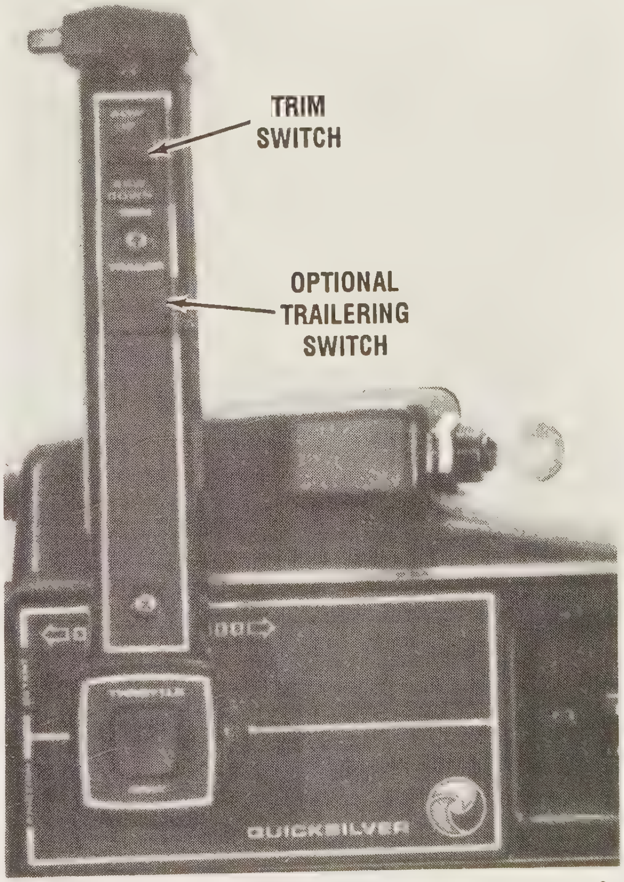
10-3 SINGLE-CYLINDER TRIM/TILT SYSTEM "A"

As explained in the chapter introduction, for easy identification, the single cylinder model has been designated System "**A**". All information, including description, operation, special instructions, bleeding the system, troubleshooting, and service of the various components is covered in this section.

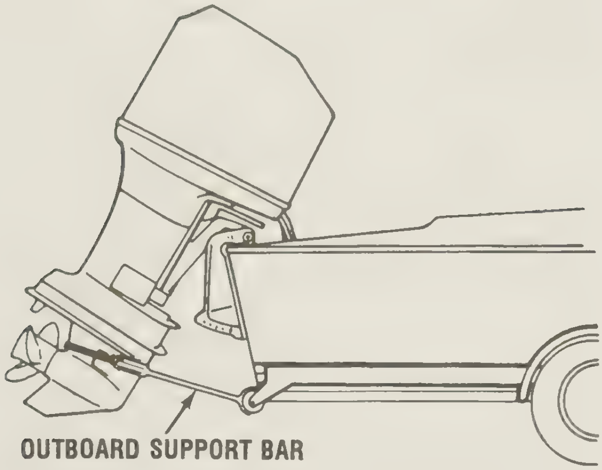
DESCRIPTION

The hydraulically powered single cylinder trim/tilt system permits changing the tilt angle of the outboard unit from the helmsperson's position. Controls and indicator for the system are located on the control panel or on the remote control handle. A set of switches is also conveniently installed on the starboard side of the powerhead in the lower cowling.

The trim angle of the lower unit is properly set when the boat is operating to give maximum performance, including comfort and safety.



Typical trim/tilt switch on the control handle of a remote control unit. An optional trailering switch, also installed on the handle, will permit raising the outboard unit, from this control position, for trailering the boat.



Simple line drawing to depict a trailer support bar in place. Such a bar may be purchased at very modest cost and is strongly recommended for use when trailering the boat with the outboard mounted on the transom.

The powered tilt system consists of a reversible electric motor, hydraulic pump, a single trim/tilt cylinder, up/down solenoids or relays, controls, a trim gauge and associated wiring.

The hydraulic pump on this model is non-repairable. If troubleshooting definitely indicates a fault with the pump, a new assembly **MUST** be obtained and installed.

The controls include an **UP** and **DOWN** trim switch, and a **TRAILERING** switch located on the remote throttle control lever. Some models may have an additional trailering switch located on the starboard side of the powerhead lower cowling. A trim position indicator gauge is installed on the control panel for easy viewing by the helmsperson. This gauge enables the person at the helm to constantly be aware of the position of the lower unit while underway.

OPERATION

As the heading suggests, this system consists of a single cylinder mounted between the two transom brackets, a pump mounted in the boat which includes an electric motor for drive and an oil reservoir. The pump is connected to the cylinder with conventional hydraulic hoses and fittings.

The system is controlled by a set of switches, one for **UP** and one for **DOWN** operation, and a trailer switch used only to tilt the outboard unit up for trailering to and from the water or for shallow water operation at idle speed.

When the **UP** switch is depressed, the **UP** pump solenoid is actuated and the circuit to the electric motor is closed. The motor will drive the oil pump forcing hydraulic fluid into the **UP** side of the cylinder and trimming the outboard unit upward until the button is released or until the trim limit cutout switch opens the circuit and stops the outboard unit swivel bracket within the limits of the clamp bracket supporting flanges.

The trim gauge advises the helmsperson of the relative position of the outboard at all times.

When the **DOWN** switch is depressed, the **DOWN** solenoid is actuated and the circuit to the pump motor is closed. The pump motor will operate in the **OPPOSITE** direction forcing hydraulic fluid into the **DOWN** side of the cylinder to trim the outboard unit down to the desired position.

Trailering and Shallow Water Operation

There are two **TRAILER** switches for energizing the **UP/DOWN** circuits of the power tilt system. One set is on the remote control power lever, the other is located on the starboard side of the powerhead. Depressing and holding either switch, will raise or lower the powerhead to the full "up" or "down" position.

When the **TRAILER** button is depressed, the **UP** solenoid is actuated and the circuit to the pump motor is closed. The pump motor drives the pump, forcing hydraulic fluid into the **UP** side of the cylinder. The **TRAILER** switch circuit bypasses the trim limit switch enabling the outboard unit to be tilted up for trailering and/or shallow water operation.

Once the outboard unit has reached its limit in either direction, continuously holding the **TRAILER** switch depressed, will cause the pump motor to labor and overheat. A thermal protection circuit breaker inside the motor case will open the motor circuit. Several minutes are required for the motor to cool and the

circuit breaker to automatically reset. After the breaker resets, power is restored to the trim/tilt motor and normal operation can resume.

If the outboard is raised to the full "UP" position, the uplock lever should be engaged. **DO NOT** use the uplock lever to "support" the outboard when the boat is being moved to and from the water on a trailer. Such action would be most **UNSAFE**. After the boat is on the trailer and **BEFORE** towing, the uplock lever should be disengaged and an outboard support bar placed between the lower unit and the trailer. Such a bracket may be purchased at modest cost from the local marine store or easily fabricated. This bracket will provide excellent support under the lower unit, not to mention "peace of mind" to the owner, as the craft is moved to and from the water.

When the boat is to be parked or stored for more than 48 hours, the outboard **SHOULD** be lowered to the full "down" or vertical position.

SAFETY WORDS

The powerhead should **NEVER** be operated above idle rpm when the outboard unit is tilted beyond the trim limit cutout point because the swivel bracket will not have side support and may break.

ALSO excessive outboard unit trim angle will starve the water pump of sufficient water causing water pump failure and/or overheating of the powerhead. Check to be sure the water level is above the gear housing water intake holes whenever the powerhead is operating.

Thermal Overload Switch

If the **DOWN** or **TRAILER** switch is kept depressed after the outboard unit reaches its end of travel, a thermal overload switch will open to prevent the pump motor from overheating and the pump will stop. The manufacturer strongly recommends the switch be released as soon as the outboard unit reaches the end of its travel.

If the cutout switch should open, **DO NOT** depress the switch for approximately one minute to allow the overload switch to cool. After about a minute the overload switch will close and the pump may again be operated.

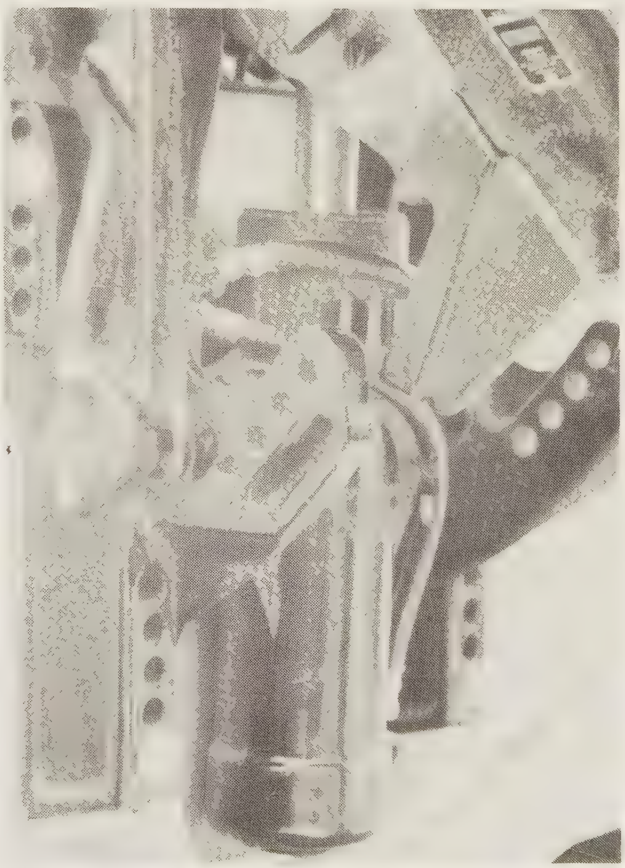
Manual Tilt Operation

The outboard unit may be raised or lowered manually, by **FIRST** turning the manual release valve (next to the "Fill/Vent" screw), fully **COUNTERCLOCKWISE**. Manually lift the lower unit and slowly raise the outboard until the tilt uplock lever can be engaged. After the tilt uplock lever is engaged close the manual release valve fully **CLOCKWISE**.

WARNING

IF THE OUTBOARD IS IN THE "UP" POSITION WHEN THE MANUAL RELEASE VALVE IS FULLY OPENED, THE OUTBOARD WILL DROP TO THE FULL DOWN POSITION RAPIDLY. THEREFORE, OPEN THE VALVE VERY SLOWLY IN AN ATTEMPT TO CONTROL THE DOWNWARD MOVEMENT. ENSURE ALL PERSONS STAND CLEAR WHEN LOWERING THE OUTBOARD IN THIS MANNER.

Lift up on the lower unit and disengage the uplock lever. If there is no fluid in the system, slowly lower the outboard unit manually. If the outboard cannot be lowered, open the manual release valve carefully **COUNTERCLOCKWISE** just a little at-a-time and slowly lower the outboard to the full "**DOWN**" -- vertical position.



Typical System "A" single cylinder installation. The pump and associated parts are installed in the boat.

HYDRAULIC SERVICING SYSTEM "A"

Servicing Fluid Reservoir

a- The powerhead **MUST BE** in the down position to properly check the reservoir fluid level. Press the **DOWN** switch on the remote control shift lever or on the powerhead lower cowling. Lower the outboard to the full down position.

b- Remove the "Fill/Vent" screw from the reservoir and check the oil level on the dip stick. The oil level should be up to the FULL mark. If the reservoir needs servicing, add a small quantity of SAE 10W-30 or 10W-40 multi-viscosity motor oil through the fill/vent port opening. Check the reservoir quantity often until the full mark is reached on the dip stick. **DO NOT** overfill the reservoir, a small area in the reservoir is needed for fluid expansion.

c- Install the Fill/Vent screw and tighten - until it contacts the pump surface. Back the Fill/Vent screw out 1-1/2 turns to properly vent the reservoir.

d- Using the **UP/DOWN** switch on the powerhead cowling, cycle the outboard to the full up and down position. Check the oil level in the reservoir with the powerhead in the full down position.

Bleeding Air From Trim/Tilt System

Activate the **UP** circuit and raise the outboard unit to the trim limit position. With the outboard in this position, push down on the lower unit. The piston should retract into the cylinder no more than 1/8" (3.2mm). If the piston retracts more than this amount, the system contains air which **MUST** be purged -- "bled" -- from the system for efficient operation.

First, check to be sure the manual release valve knob is turned full right (clockwise) and the **FILL/VENT** screw is backed out 1-1/2 turns.

Next, activate the **TRAILER** circuit and raise the outboard unit to full **UP** position. If the unit stops part way, refill the pump to the **ADD** line on the dipstick, not the **FULL** line. Continue raising and filling the pump with hydraulic fluid until the outboard unit raises to the full **UP** position.

Now, activate the **DOWN** circuit and lower the outboard unit to the full **DOWN** position. If the pump sounds as if it is running free and the outboard does not move down, fill the pump with fluid to the **ADD** line on the dipstick.

At this point, "bleed" any remaining air from the system by moving the outboard unit several times through the entire "Up/Down" range. Each time the unit is lowered to the full **DOWN** position, check the fluid level in the reservoir and fill to the **FULL** line in the dipstick.

Finally, tighten the **FILL/VENT** screw, and then back it out 1-1/2 turns to vent the pump reservoir.

TROUBLESHOOTING TRIM/TILT SYSTEM "A"

If a problem is encountered with the trim/tilt system, make an attempt to determine if the problem is in the electrical system or in the hydraulic system. The following symptoms can help determine which area to begin troubleshooting.

Does the pump motor operate when the trim UP/DOWN or TRAILER switches are activated?

YES -Troubleshoot the hydraulic system.
NO - Troubleshoot the electrical system.

HYDRAULIC SYSTEM

The trim/tilt system is considered a "closed" system. The only route for contaminants to enter is through the "fill" opening. Therefore, seldom does the hydraulic system cause trouble.

However, if any of the following problems exist, the hydraulic system will require attention.

Outboard unit fails to move to full **DOWN** position or moves part way with jerky motion.

Outboard unit thumps when shifted.

Outboard unit trails out when backing off throttle when underway at high speed.

Outboard unit fails to hold trimmed position or fails to hold tilted position for long period.

Outboard unit fails to hold trim position when backing down in reverse.

If any of the above listed problems are encountered, perform the following listed checks.

a- Check to be sure manual release valve is fully tightened -- **CLOCKWISE**.

b- Check the pump oil level and fill, if necessary.

c- Make a visual inspection of the system for external leaks. Tighten the fitting or replace the defective part, if a leak is discovered.

d- Check for air in the system. "Bleed" (purge) air from the system, if necessary, according to the procedures listed earlier in the this section.

e- Remove the manual release valve and inspect the **O**-rings for damage. If the O-rings are damaged, the release valve **MUST** be replaced.

WARNING

IF THE OUTBOARD IS IN THE "UP" POSITION WHEN THE MANUAL RELEASE VALVE IS FULLY OPENED, THE OUTBOARD WILL DROP TO THE FULL DOWN POSITION RAPIDLY. THEREFORE, OPEN THE VALVE VERY SLOWLY IN AN ATTEMPT TO CONTROL THE DOWNWARD MOVEMENT. ENSURE ALL PERSONS STAND CLEAR WHEN LOWERING THE OUTBOARD IN THIS MANNER.

SPECIAL MANUAL RELEASE WORDS

Two different manual release valves have been used with trim/tilt System **"A"**. The end of one type is tapered to a point and uses **TWO O**-rings. The other valve has a blunt end and uses **THREE O**-rings. The valves are **NOT** interchangeable. Therefore, be sure the same type valve is purchased for a replacement. A simple guarantee is to present the defective valve to the parts department at the marine store.

f- Remove and clean the two pump filters. This is accomplished by first removing the pump unit from the boat; draining the hydraulic fluid; removing the reservoir from the pump adaptor assembly; and then removing the filters using a pair of pliers and a twisting and pulling motion, as described and shown in the pump service section following electrical troubleshooting.

g- If the outboard unit fails to hold a trimmed position or will not remain tilted for an extended period of time, and the above six checks are all satisfactory, the trim pump adaptor may be purchased in "Kit" form. Detailed instruction for installation are included in the package.

ELECTRICAL SYSTEM TROUBLESHOOTING

During the troubleshooting process -- after performing a repair or part replacement, check the system for proper operation before preceding to the next troubleshooting step.

"TRAILER" Circuit Inoperative "UP" Circuit OK

a- Obtain an ohmmeter and set it for continuity testing. Check for continuity of the Blue/White wire from the **"UP"** solenoid terminal to the remote control wire harness connector. If there is no continuity, the Blue/White wire is broken or damaged -- repair or replace the wire. If the continuity check is good, perform the next step.

b- Disconnect the battery cables from the battery. Disconnect the remote control wire harness closest to the remote control. Connect the ohmmeter to the Red/Purple and Blue/White wire terminals on the remote control, and then press the **TRAILER** button. If there is no continuity, the **TRAILER** button is defective and **MUST** be replaced.

"UP" and "TRAILER" Circuit Inoperative -- "DOWN" Circuit OK

Obtain a VOA meter and set the switches for 12VDC reading. Connect the Red meter lead to the **UP** solenoid terminal with the Blue/White wire connected. Connect the Black meter lead to the adjacent terminal with the Black wire attached. Press the **TRAILER** switch and observe the meter for a voltage indication. If voltage is indicated, the **UP** solenoid is defective and **MUST** be replaced. If no voltage is observed, the Blue/White or Purple/White wire leads from the trim solenoids to the trim switches are defective or damaged. Repair or replace the damaged wiring.

"UP", "DOWN" and "TRAILER" Circuits -- All Inoperative

a- Obtain a VOA meter and set the switches for 12VDC reading. Connect the Red meter lead to the **UP** solenoid positive terminal and the Black meter lead to either ground terminal with the Black wires attached. If **NO** battery voltage is indicated, check the 90-amp circuit breaker on the pump motor bracket. The indication is the breaker has not opened. Check the battery leads for tightness and/or corrosion. Check the battery for a full charge.

If all checks are good, the pump motor is defective and **MUST** be replaced. If the battery voltage check is **GOOD**, proceed to the next step.

b- Connect the Red meter lead to the **UP** solenoid terminal with the Blue/White wire connected. Connect the Black meter lead to a good ground. Press the **TRAILER** switch and

observe the meter for a voltage indication. If battery voltage is present and the pump motor fails to operate, repair or replace the motor. If there was **NO** indication of battery voltage, move on to the next step.

c- Connect the Red meter lead to the Red/Purple wire lead on the remote control handle **TRAILER** switch. Connect the Black meter lead to a good ground. If there is **NO** voltage indication, check the power cable from the battery to the trim solenoids. Check the 20-amp inline fuse on the Red/Purple wire lead from the down solenoid. Check the battery positive lead and the trim/tilt system power connection at the powerhead cranking solenoid.

If battery voltage is indicated, check all the trim harness connectors for a good tight connection. Check the three solenoid circuit wires (Green/White, Blue/White and Purple/White) for the possibly of them being severed or heavily damaged. Repair the damaged wiring or replace the harness.

DOWN Circuit Inoperative
"UP" Circuit OK

a- Connect the Red meter lead to the down solenoid terminal where the Green/White wire from the pump motor is connected. Now, connect the Black meter lead to the solenoid Black ground wire terminal. Press the **DOWN** trim/tilt switch and observe the meter for a voltage indication.

If battery voltage is indicated, move the Red meter lead to the positive (battery) side of the down solenoid. If battery voltage is now indicated, replace the defective down solenoid.

If **NO** voltage was indicated in step "**a**" above, move the Black meter lead to the Black ground wire terminal on the up solenoid. Press the **DOWN** trim button -- battery voltage should be indicated. If voltage is indicated, repair or replace the defective Black ground wire between the two solenoids. If **NO** voltage was observed on the meter, proceed to the next step.

b- Connect the Red meter lead to Green/White wire on the Trim switch located in the remote control handle. Connect the Black meter lead to a good ground. Depress the trim switch in the **DOWN** position. If voltage is indicated, the Green/White wire from the Trim switch to the down solenoid is damaged. Repair or replace the defective wire. If there is **NO** battery voltage indication, proceed to the next step.

c- Connect the Red meter lead to the Red/Purple wire lead on the Trim switch. If battery voltage is indicated the Trim switch is defective and **MUST** be replaced. If **NO** battery voltage is indicated, the Red/Purple lead from the solenoid to the Trim switch is damaged. Repair or replace the defective wire.

"UP" Circuit Inoperative
"TRAILER" Circuit OK

a- Place the outboard in the full Down position. Disconnect the Black wire with the Purple sleeve from the Purple/White wire at the bullet connector. Connect the Red meter lead to the Purple/White wire and the Black meter lead to the Up solenoid ground terminal. Press the Trim switch button in the **"UP"** position. If **NO** battery voltage is indicated, proceed to Step **c**. If battery voltage is observed on the meter, proceed to Step **b**.

b- Connect the Black wire with the Purple sleeve to the Purple/White wire at the bullet connector. Disconnect the Blue/White wire from the Black wire with the Blue sleeve at the bullet connector. Now, connect the meter Red lead to the Black wire with the Blue sleeve and the Black meter lead to the **UP** solenoid ground. Press the Trim Switch in the **UP** position and check for battery voltage indication. If battery voltage is indicated, the Blue/White wire from the bullet connector to the **UP** solenoid terminal is damaged. Repair or replace the damaged wire. If **NO** battery voltage was observed, check adjustment of the trim limit switch. The trim limit switch may be defective.

c- Move the Red meter lead to the Red/Purple wire terminal on the Trim switch in the remote control handle. If **NO** battery voltage is observed, the Red/Purple wire between the **TRAILER** switch and the Trim switches in the remote control handle are defective. Repair or replace the defective wire. If battery voltage is indicated, proceed to the next step.

d- Connect the Red meter lead to the Purple/White wire terminal on the Trim switch in the remote control handle. Press the Trim switch in the **UP** position and observe the meter. If battery voltage is indicated, the Purple/White wire from the Trim switch to the bullet connector where the Black wire with the Purple sleeve connect is damaged. Repair or replace the damaged wiring. If **NO** voltage was observed, replace the defective Trim switch in the remote control handle.

ELECTRICAL COMPONENT TESTING

The following tests and checks are provided to verify operation of individual electrical components on system "**A**".

USEFUL WORDS

Use the accompanying electrical functional diagrams on this page and the next page to identify test points called out in the test steps. The lettered test points called out in the various tests are identified on the large diagram.

Solenoid Bench Test

The following simple quick test can be performed to check the integrity of the solenoid. The small functional diagram on this page should indicate test points mentioned in the text.

a- Obtain an ohmmeter and set the meter switches for continuity reading. Connect the meter leads to the two large terminals on the solenoid, the meter should indicate no continuity. This indicates the solenoid is open.

Now, connect a 12-volt source (battery) to the two small terminals on the solenoid. An audible "click" should be heard and the meter should indicate 0-ohms or full continuity. The "click" sound verifies the plunger inside the solenoid is being drawn up making contact with the inside terminals and closing the circuit.

b- If the ohmmeter indicates a resistance in the solenoid and/or a "click" is not heard, the solenoid is defective and must be replaced.

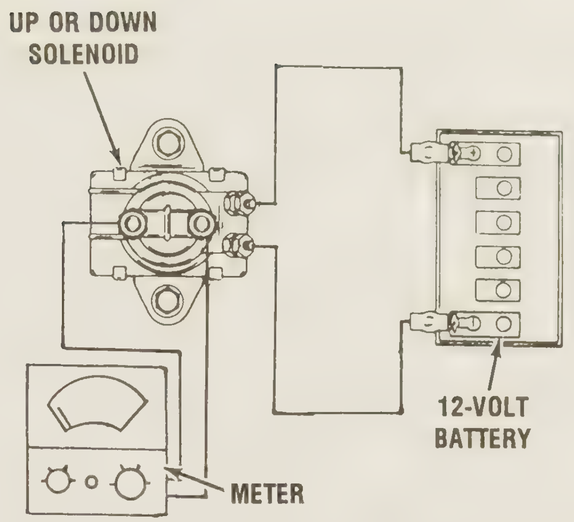
If the solenoid checks are OK, test the switches in the control handle and the wiring from the remote control switches back to the solenoids.

GOOD WORDS

Use the large functional schematic on the following page when making the remainder of electrical tests in this section. The lettered test points called out in the text are clearly indicated on the schematic.

Pump Motor Test

Connect a 12-volt power source (+) to the "Up" solenoid terminal where the pump motor Blue/White wire lead is connected -- point "**D**". Connect the negative (-) side of the 12-volt power source to the pump motor case ground -- point "**K**". The pump motor should operate. If the pump motor fails to operate, check the pump thermal overload switch.



Functional diagram depicting a battery hooked up directly to one of the solenoids for testing.

Thermal Overload Switch Test

Obtain an ohmmeter and set the meter switches for continuity testing. Connect the Red meter test lead to the pump motor Blue/White wire lead -- point "**E**". Connect the Black meter test lead to the pump motor ground or mounting stud -- point "**K**". Continuity should be indicated on the meter. If continuity is not indicated, the thermal overload switch is defective and **MUST** be replaced.

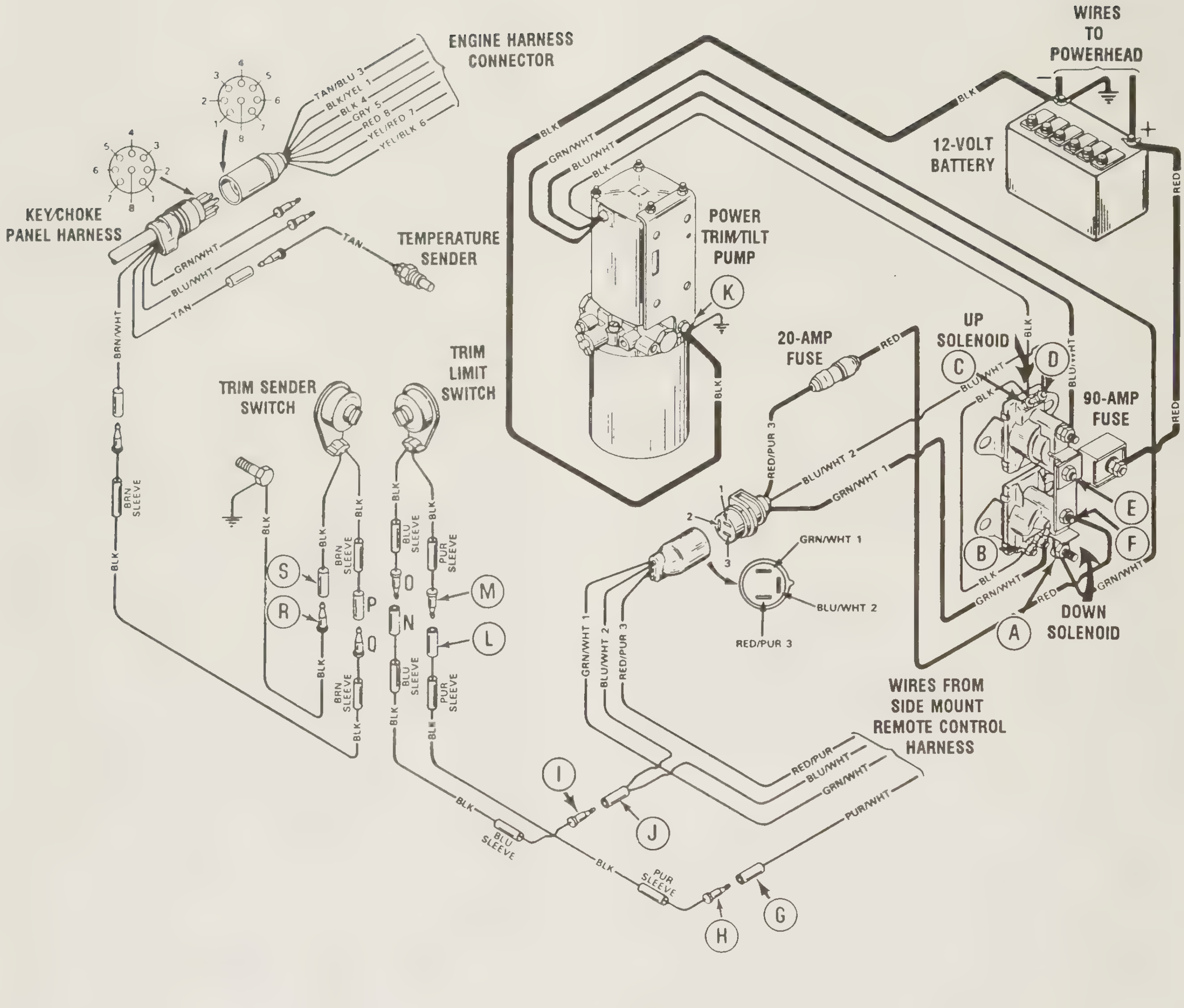
BAD NEWS

The thermal overload switch is not serviced separately, but is part of the field and frame assembly on the pump motor. Replacement of the field and frame requires the pump motor be completely disassembled.

Circuit Breaker and Fuse Test

a- Obtain an ohmmeter and set the switches for 12-VDC readings. Connect the Red meter test lead to the battery cable connection on the circuit breaker terminal -- point "**E**". Connect the negative meter lead to a good ground -- point "**K**". The meter should indicate 12-volts. If there is no voltage indication, check the battery charge and the positive cable from the battery to the circuit breaker. If there is 12-volts indicated, continue with the next step.

b- Disconnect the three wire harness connector from the trim/tilt motor. Connect the Red meter test lead to the #3 pin (Red/Purple) wire on the trim/tilt motor and the Black meter



Working functional diagram showing test locations -- circled letters -- referenced in the text.

test lead to a good ground. The meter should indicate 12-volts. If the meter does not indicate voltage, the 20-amp fuse is defective and **MUST** be replaced.

Trim Limit Switch Test

a- Trim the powerhead to the full "Down" position. Disconnect the Black wire with Purple sleeve -- point "**H**" from the Purple/White wire bullet connector -- point "**G**". Disconnect the Black wire with the Blue sleeve -- point "**I**" from the Red/Purple wire bullet connector -- point "**J**". Set the ohmmeter to the R x 1 scale and connect the meter leads to the two black leads from the limit switch -- points "**H**" and "**I**". The meter should indicate continuity. If there is no continuity, either the trim angle is out of adjustment or the trim limit switch is defective.

b- Connect the Black wire with Purple sleeve -- point "**H**" to the Purple/White wire lead -- point "**G**". Connect the Black wire with the Blue sleeve -- point "**I**" to the Blue/White wire -- "**J**". Press the "**UP**" trim button and hold until the outboard stops movement. If the outboard stops before reaching the trim stop point or continues beyond (less than 1-1/2" inches of swivel bracket engagement with the transom bracket), the trim angle is out of adjustment or the trim limit switch is defective. Perform the following Trim Limit Switch Adjustment before replacing the trim limit switch.

Trim Limit
Switch Adjustment

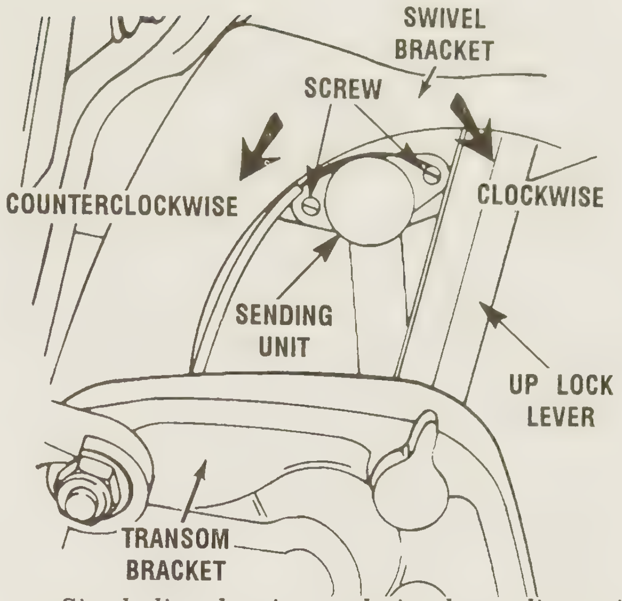
The following procedure covers adjusment of the trim limit switch. The amount of trim is controlled by this switch.

CAUTION

Engagement of the swivel bracket with the transom bracket MUST NOT be less than 1-1/2". If the unit is allowed to trim higher, the swivel bracket could break.

After the trim adjustments are completed, the craft should be tested at all speeds and power settings for stable ride and steering control.

Begin the adjustment by loosening the clamp screws, and then rotating the switch **CLOCKWISE** to reduce the amount of outward trim. Rotate the switch **COUNTER-CLOCKWISE** to increase the amount of outward trim. After a minimum of 1-1/2" of engagement of the swivel bracket with the transom



Simple line drawing to depict the sending unit installation and direction of adjustment for trim out or in.

bracket has been obtained, tighten the switch clamp screws and retest the trim stop position.

Following final adjustment, **TAKE TIME** to measure to ensure the engagement has remained at 1-1/2" or more. If the trim stop position will not adjust, the trim switch is defective and **MUST** be replaced.

Trim Indicator
Sending Unit Test

Place the outboard unit in the full "Down" position. Disconnect the Black wire to ground and the Black wire with a Brown sleeve at the trim indicator sending unit -- point "**Q**". Set the ohmmeter to the R x 1 scale and connect the meter leads to the two black leads on the trim indicator sending unit -- points "**S**" and "**P**".

Press the "**TRAILER**" switch on the remote control handle and raise the outboard to the full "Up" position. As the outboard rises, the ohmmeter should swing from the left to the right (full scale). If the meter fails to swing from left to right, the sending unit is defective and must be replaced. If the meter **DOES** move smoothly, the sending unit is satisfactory. Check for defective wiring to the gauge and the gauge.

Trim Indicator
Gauge Adjustment

Trim the outboard unit to the full "Down" position. Set the key switch to the **RUN** position and note the position of the needle on the trim indicator gauge. The needle should point to the full "**IN**" position or to the bottom of the green arc on the gauge, depending on the model gauge installed.

If not, raise the outboard to the full "Up" position and engage the tilt lock lever. Loosen the screws on the trim sending unit. Rotate the sending unit **CLOCKWISE** to lower the gauge needle and **COUNTERCLOCKWISE** to raise the gauge needle. Make small adjustments to the sending unit and tighten the screws. Disengage the uplock lever and lower the outboard to the full "Down" position. Once again, check the needle position on the trim gauge. Repeat this procedure, making small adjustments to the sending unit each time, until the gauge needle is indicating correctly.

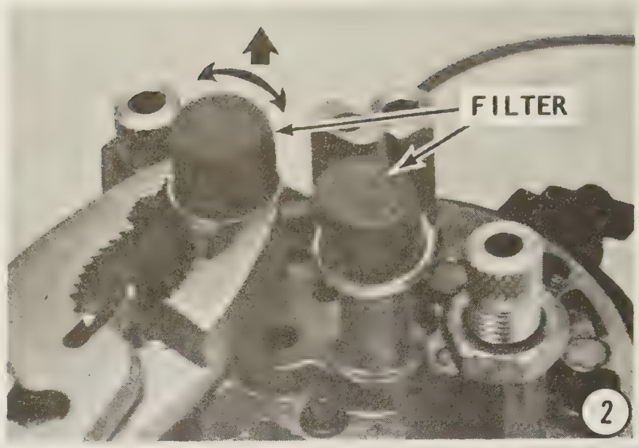
REMOVAL/DISASSEMBLING TRIM/TILT SYSTEM "A"

Pump Removal From Boat

1- Disconnect the pump leads from the battery, negative lead first. Disconnect the 3-pronged connector from the pump. Check to be sure the manual release valve knob is fully tight (clockwise). Remove the trim hoses from the pump and plug the open end of the hoses to prevent contamination. Remove the bolt and lockwasher and lift the pump free of the mounting bracket.

Servicing Pump Filters

2- Remove the oil reservoir from the pump adaptor. Work the filters free by pulling upward and rotating them right and left with a pair of pliers. To install the filters, push them onto the inlet tubes and then tap them into place using the proper size socket and a hammer. Install the oil reservoir O-ring, and then the reservoir. Install the pump into the boat. Finally, fill the reservoir and "bleed" the system.



Pump Installation In Boat

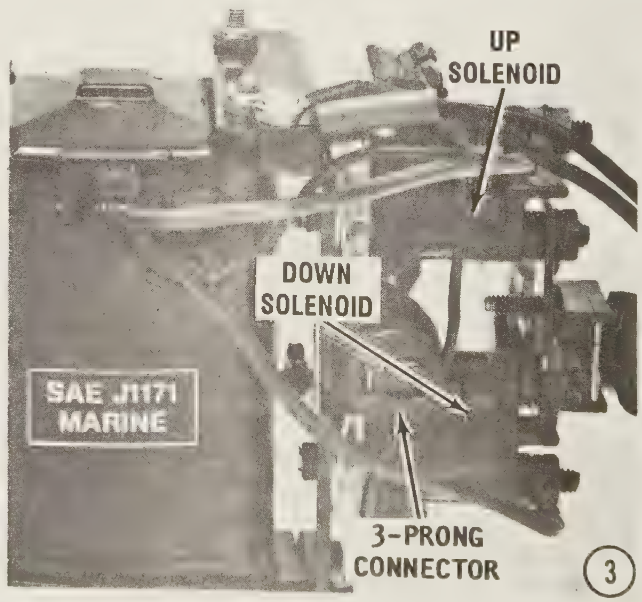
3- Slide the pump into the mounting bracket and secure it in place with the bolt and lockwasher. Connect the hydraulic hoses to the pump. **TAKE CARE** not to crossthread or overtighten the fittings. Connect the 3-pronged connector to the pump. Connect the pump leads to the battery, positive lead first. Turn the manual release valve knob to the fully tightened position (clockwise). Check the oil level and add fluid, if necessary. "Bleed" the system of any air. Check the system for leaks.

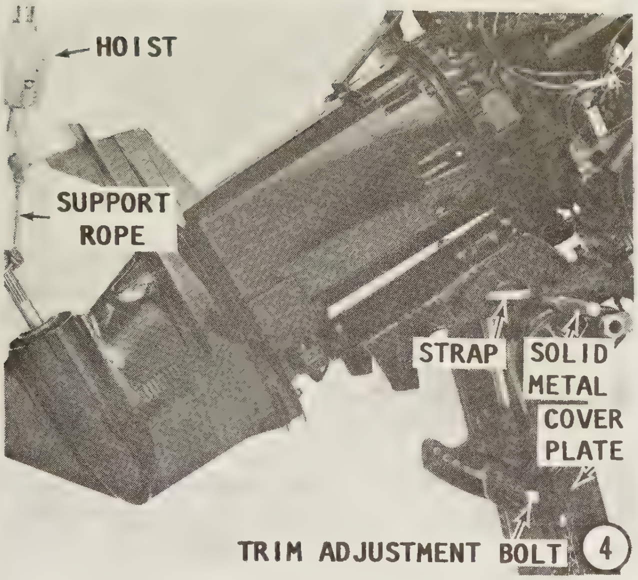
Cylinder Removal And Disassembling

4- Raise the outboard unit, manually, to the full upright position.

SAFETY WORDS

As a safety measure to prevent accidental movement of the outboard while work is

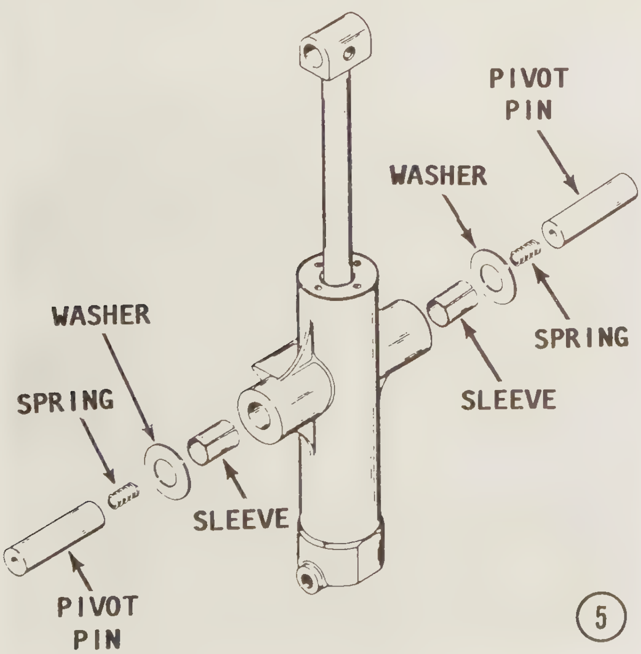


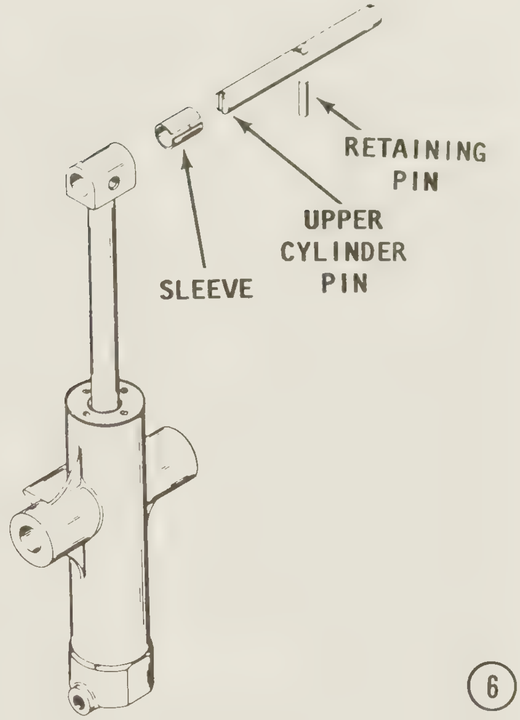


being performed on the trim/tilt system, the unit **MUST** be safely secured in the fully raised position. This can be accomplished by either attaching a hoist to the lower unit and taking a strain to prevent the outboard unit from falling **OR** by sliding a solid metal piece of bar stock or rod stock between the mid section and the transom clamp bracket, **OR** both as shown in the accompanying illustration.

Remove the trim adjustment bolt from the transom clamp bracket.

5- Disconnect the hydraulic hoses from the cylinder and plug the open ends to prevent contamination. Remove the cover plate from each side of the outboard unit clamp bracket.

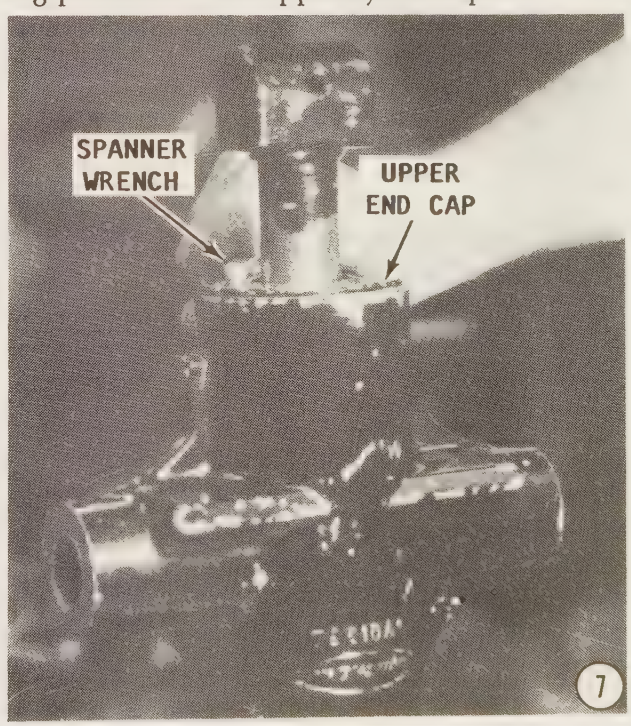


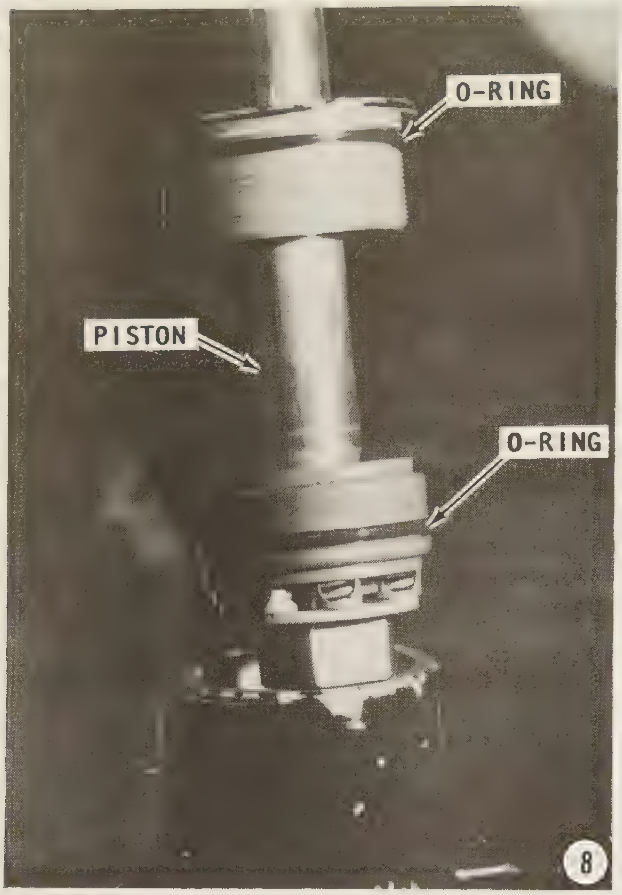


Thread a 5/16x18 bolt into the pivot pin, one on each side, as an aid in removing the pivot pins. Pull on each bolt and remove both pivot pins.

Remove the straps which secure the trim sender and the trim out limit switch. Remove the switches from the swivel bracket.

6- Support the cylinder because it will be free once this step is completed. Use a blunt punch and hammer and drive the small retaining pin free of the upper cylinder pin.





After the retaining pin is free, drive the upper cylinder pin out of the swivel bracket. **TAKE CARE** not to damage the slotted ends of the upper cylinder pin. Remove the sleeve from the upper end of the piston rod.

7- Clamp the cylinder in a vise equipped with soft jaws. Use a spanner wrench and rotate the upper end cap **COUNTER-CLOCKWISE** until it is free of the cylinder.

8- Pull the piston straight up and out of the cylinder.

CLEANING AND INSPECTING GENERAL PRACTICE

Check all O-rings for any damage. Actually, good shop practice would dictate new O-rings be installed anytime a part is disassembled exposing an O-ring.

Pump and Motor

The pump **CANNOT** be serviced. Therefore, if troubleshooting indicates the pump has failed, it **MUST** be replaced.

However, the adaptor between the pump and the motor may be replaced. A kit is available with full installation instructions included.

The electric motor is very similar to other electric motors used on the outboard unit. Brush replacement, armature testing, and field tests may be made in the same manner. Therefore, the motor can be checked, tested, and serviced following the procedures outlined in Chapter 7 for other motors.

Check the mating surfaces of the motor and pump to ensure they are clean and undamaged.

Manual Release Valve

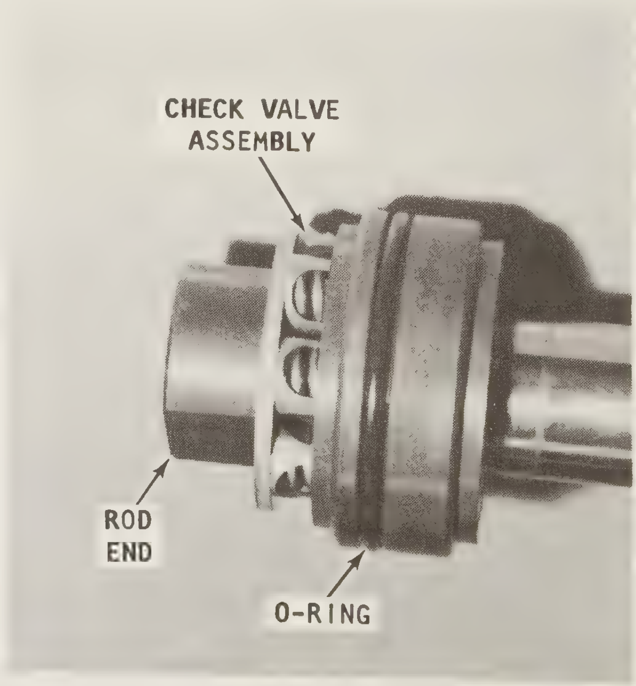
One style manual release valve has three O-rings and the other style has only two. The valves are **NOT** interchangeable. Therefore, be sure to replace the valve with the same style as the one removed.

Cylinder

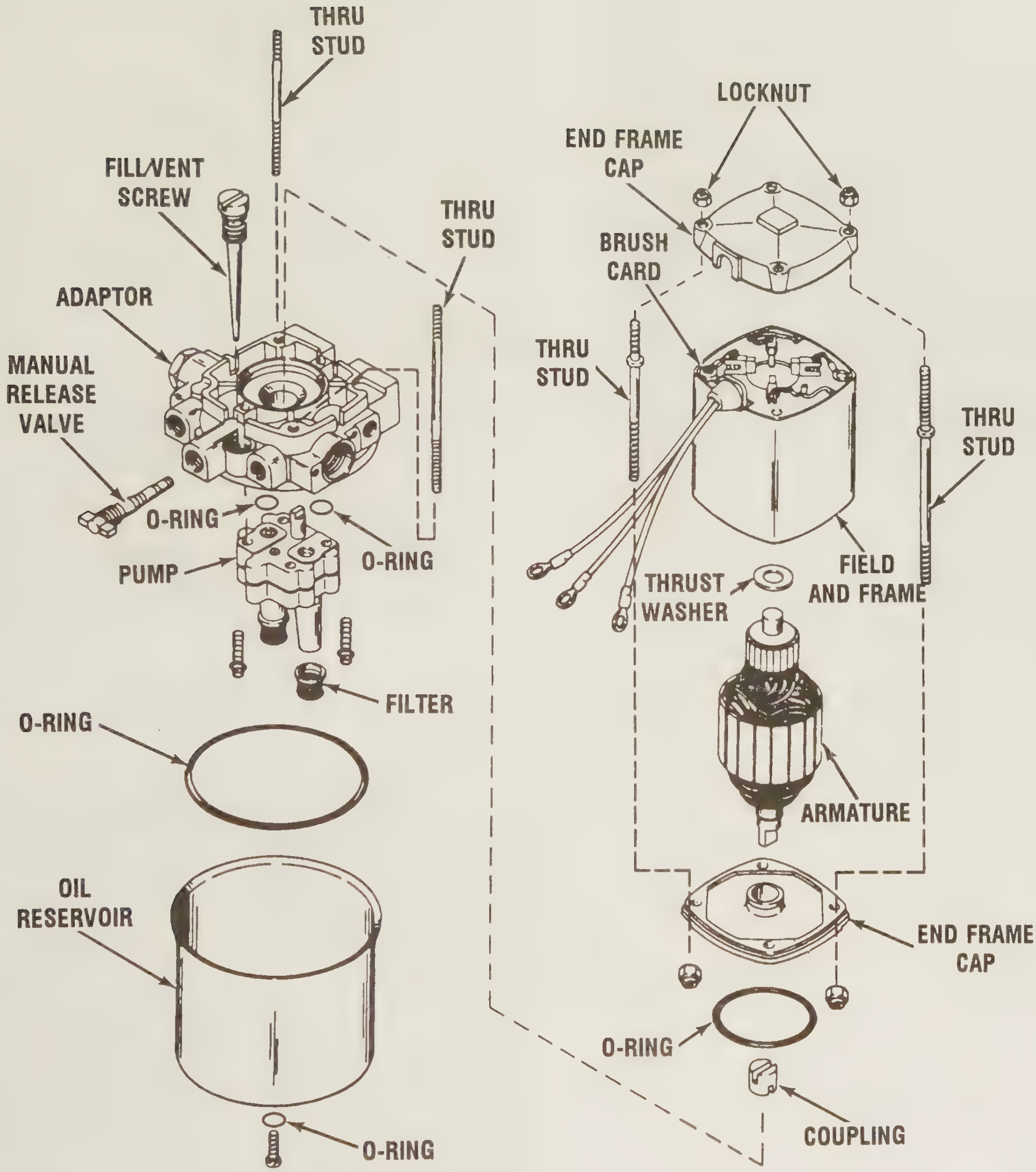
Inspect the interior of the cylinder for any sign of scoring or roughness. Inspect the seal located in the recess of the end cap. If the seal is damaged or fails to keep the trim piston rod clean, replace the seal. This is accomplished by first prying the old seal from the top of the cap with a screwdriver, and then pushing the new seal into place with the seal lip facing **UP**.

Examine the check valves and clean them thoroughly of any foreign material.

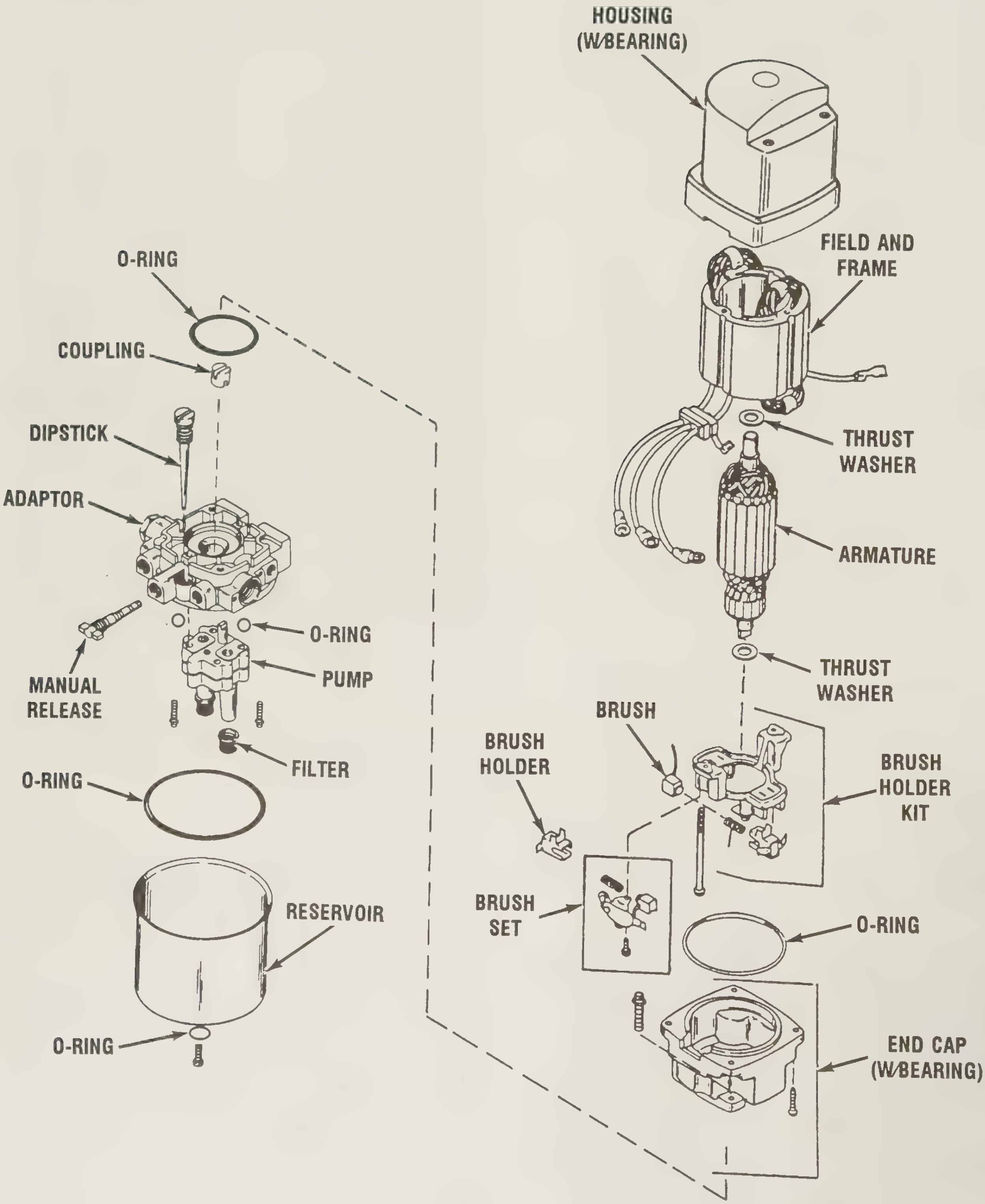
Clean all parts with solvent, and then blow them dry with compressed air.



Lower end of the piston with the O-ring, check valve springs, and rod end identified.



Exploded drawing of Design 1 -- pump and motor assembly for the single cylinder trim/tilt System "A". Major parts are identified.



*Exploded drawing of Design 2 -- pump and motor assembly -- for the single cylinder trim/tilt System "**A**". Major parts are identified.*

CYLINDER ASSEMBLING AND INSTALLATION

1- Coat **NEW O**-rings with SAE 10W-30 or 10W-40 motor oil. In tropical areas, SAE 30W oil may be used. Apply oil to the inside surface of the cylinder. Install the **NEW O**-rings onto the piston.

Slide the piston into the cylinder, and then thread the end cap into the cylinder.

2- Tighten the end cap with a spanner wrench.

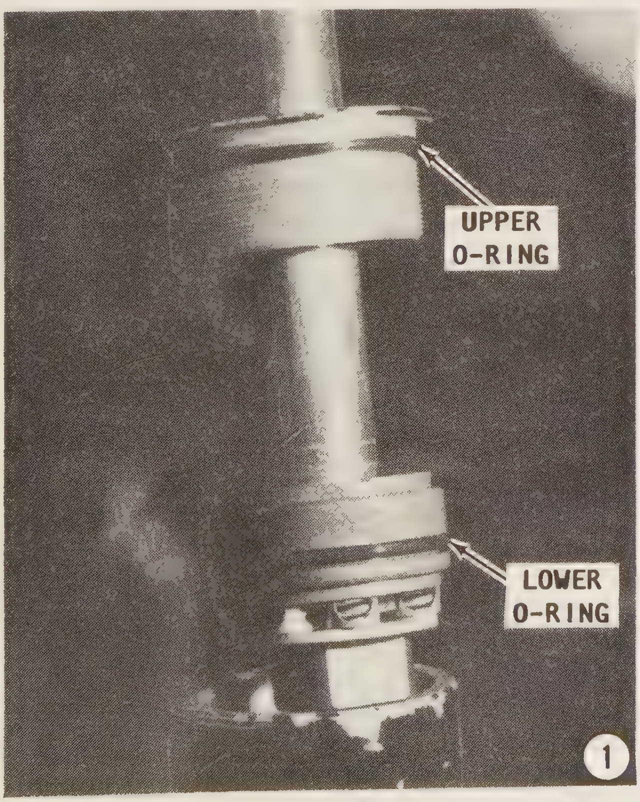
3- Insert the sleeve into the piston rod end. Rotate the sleeve until the slot in the sleeve is aligned with the hole through the rod end. This alignment is necessary to permit the retaining pin to pass through.

Now, insert the retaining pin into its hole and just barely through the slot in the sleeve. The pin will hold the sleeve in position. Move the assembled cylinder into place between the transom clamp brackets.

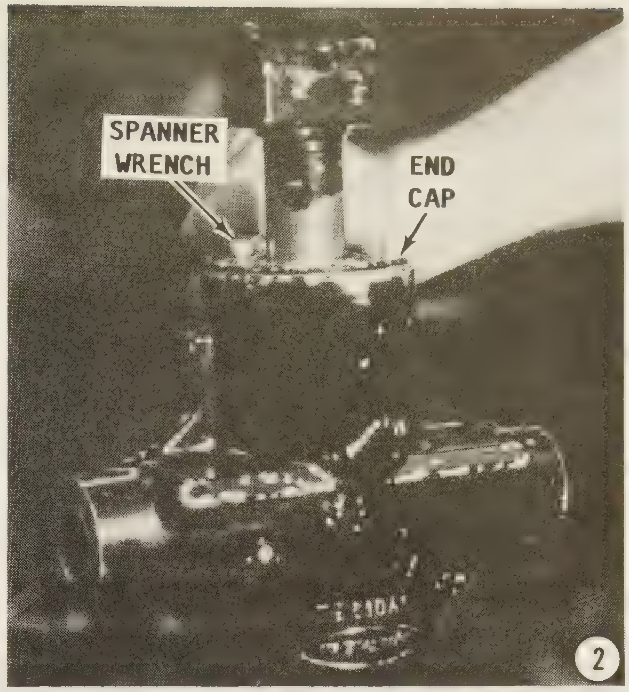
Next, coat the upper cylinder pin with Multipurpose lubricant. Roughly align the hole in the cylinder pin with the hole in the rod end, and then slide the pin through the clamp bracket, rod end, and other clamp bracket.

SPECIAL GOOD WORDS

Both ends of the cylinder pin have a slot. Guess why? To provide a means of rotating the pin with a screwdriver to align the hole in the pin with the retaining pin and thus enable the retaining pin to be driven through. The pin is a snug fit to secure the cylinder pin in place.

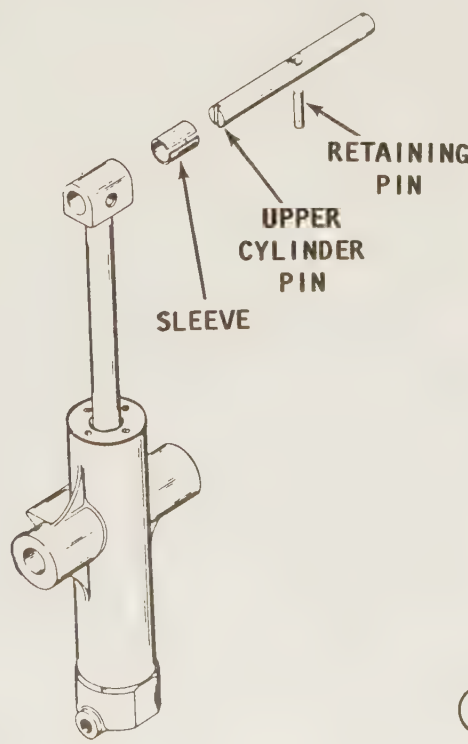


1



2

4- Coat the pivot pin with Multipurpose lubricant. Assemble the pivot pin and associated parts as shown in the accompanying illustration. Install the cover plates to secure the pivot pin in place.



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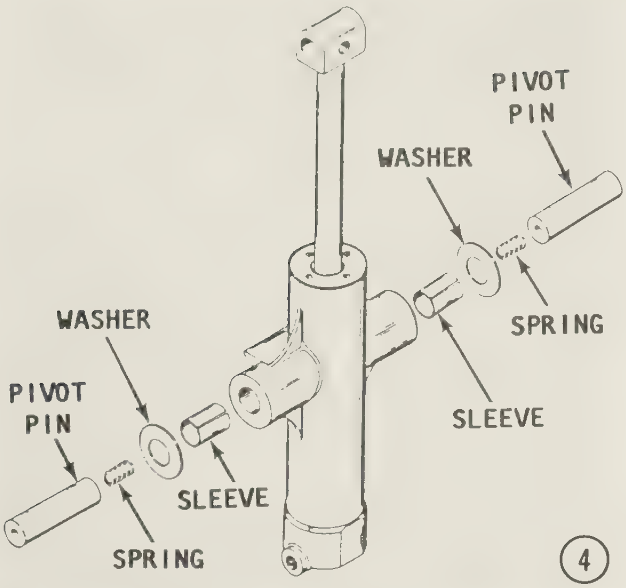


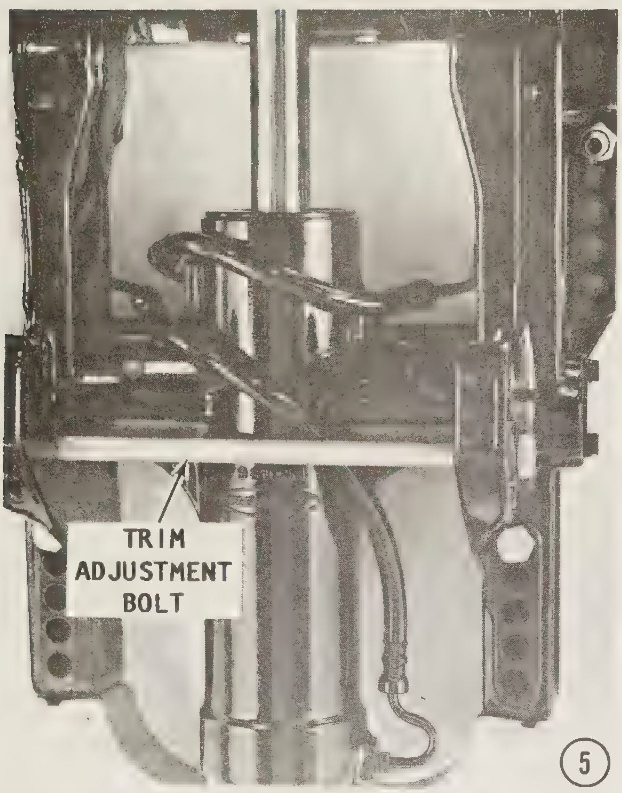
4

5- Remove the plugs and connect the hydraulic hoses to the cylinder. Install the trim sender and trim out switches to the swivel bracket. Install the trim adjustment bolt into the clamp bracket and secure it in place with a locknut. **DO NOT** overtighten the locknut. Tighten the nut only enough to remove any "play".

Obtain the help of an assistant. Remove the supporting equipment, the solid metal bar or rod and the hoist, if one was used. Lower the outboard unit.

6- Connect the 3-prong connector to the pump. Check to be sure the manual release valve is fully seated -- **CLOCKWISE**. Fill the pump reservoir with hydraulic fluid, and then "bleed" air from the system. See Page 10-6.

Check the completed work for proper operation and no leaks.



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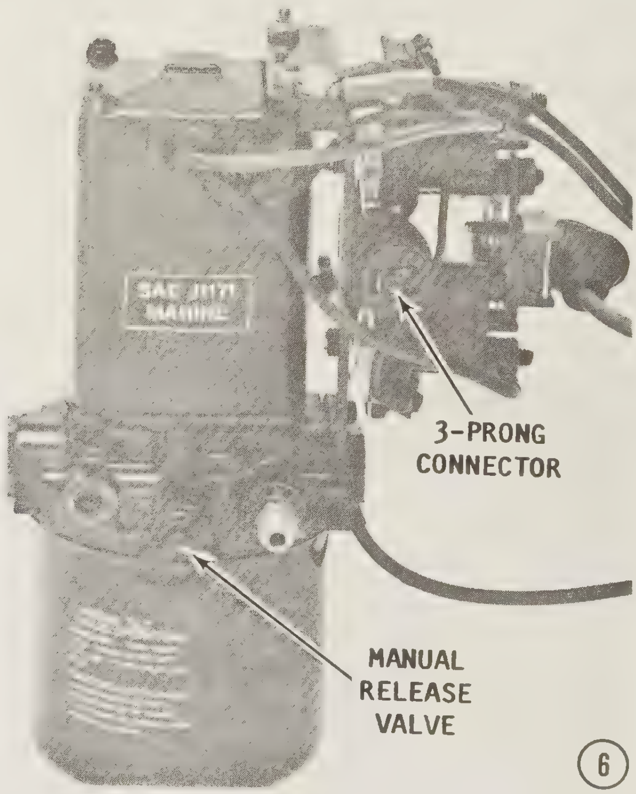


6

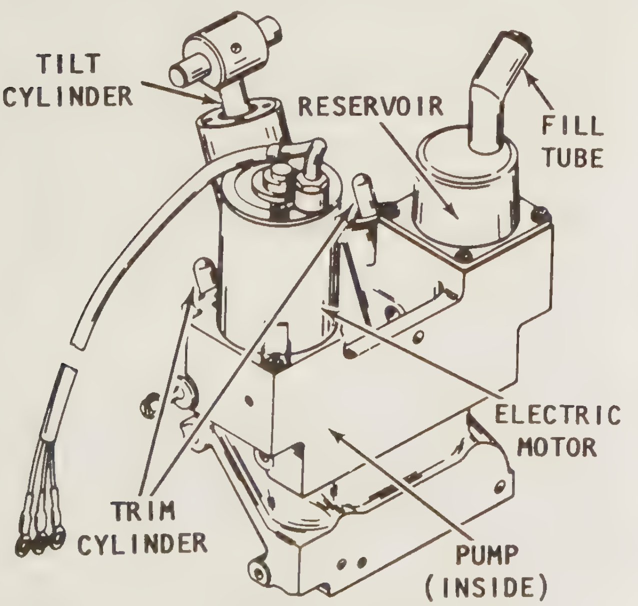
10-4 SYSTEM "B" MODELS WITH 3-CYLINDERS TWO TRIM AND ONE TILT

DESCRIPTION AND OPERATION

Three designs of Trim/Tilt System "B" have been used on certain outboard units covered in this manual. All three systems work identically, but engineering changes and improvements have resulted in some minor component changes along with modification to the disassembly and assembly procedures. The unique differences between these units are as follows:

Design I	Side Fill Reservoir with Round Motor Frame and Internal Hydraulic Pump
Design II	Side Fill Reservoir with Square Motor Frame and Internal Hydraulic Pump
Design III	Rear Fill Reservoir with Square Motor Frame and External Hydraulic Pump

Due to the manufacturers constant improvements from one model year to the next, some outboard models may have any one of the three designs described above. However most of the procedures are identical. Where differences do occur, these differences are clearly indicated. Therefore, before starting work, carefully examine the trim/tilt system on the outboard unit being serviced, then match the physical characteristics with the illustrations provided, to ensure the proper procedures are followed when differences are indicated. Once the model is identified, proceed with the work for that particular model.



Line drawing showing the back side of the System "B" Power Trim/Tilt with major parts identified.

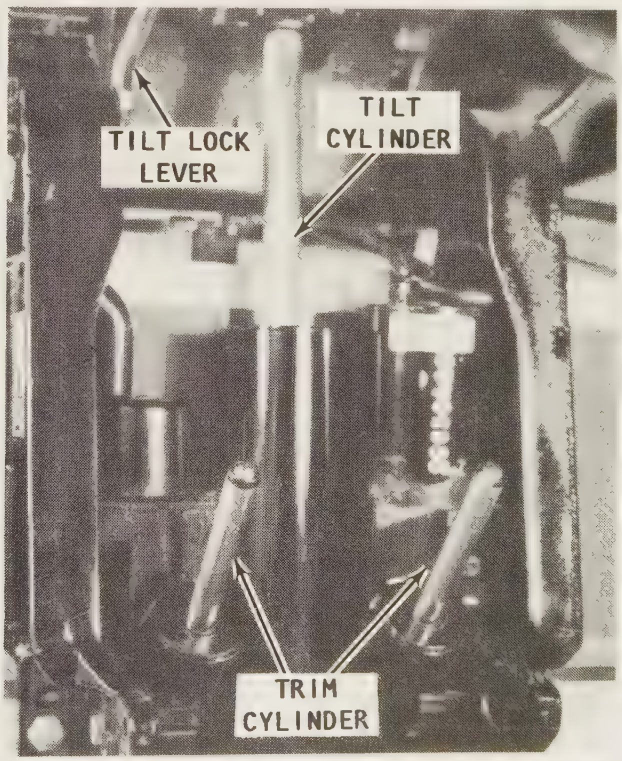
The trim/tilt system consists of an electric motor, pump, pressurized fluid reservoir, two small trim cylinders and one large tilt cylinder.

The remote control throttle lever contains switches for adjusting the trim angle, raising the outboard for shallow water operation, and tilting the outboard fully up for trailering.

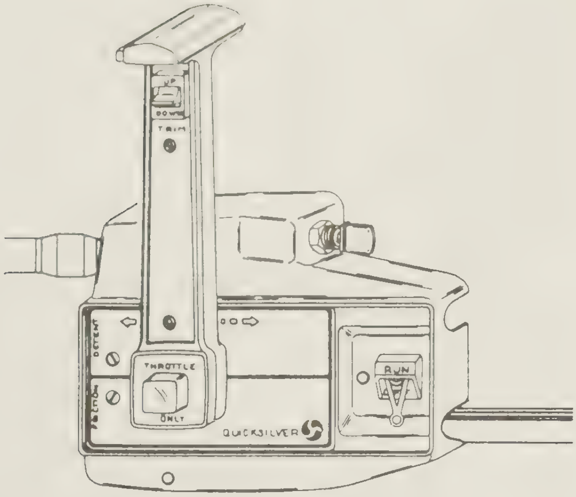
An electronic trim position indicator (optional equipment), may be installed to provide the helmsperson with a visual reference of the outboard trim angle. This indicator system consists of a transducer mounted on one end of the tilt cylinder hinge pin, and a trim gauge mounted on the control panel. As the angle of the outboard changes, the transducer senses the change altering the voltage level to the gauge on the control panel.

Trimming Outboard Unit Up

Depressing the **UP** button will actuate the "up" solenoid and close the circuit to the electric motor. The electric motor will drive the pump forcing fluid into the "up" side of the two trim cylinders.



The outboard unit raised to the full up position by the larger center tilt cylinder. The tilt lock lever has been engaged to take the weight from the cylinder.

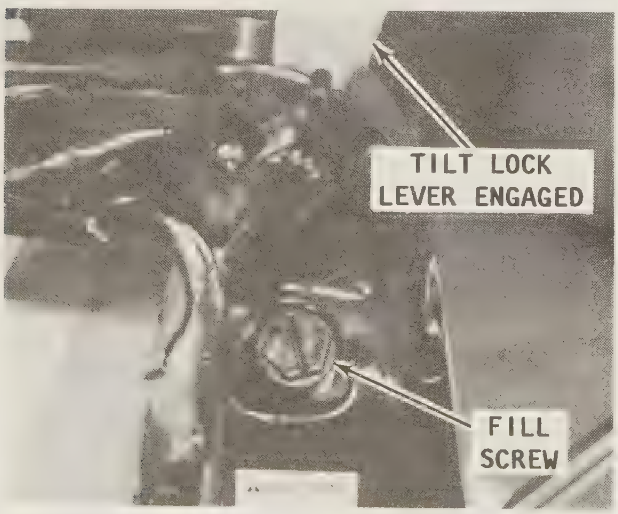


Controls for the System "B" power trim/tilt do not have a "Trailering" button. Holding the UP button depressed will activate the center tilt cylinder to raise the outboard.

As the trim cylinders extend, the outboard unit may be raised to the desired angle. The system is designed to prevent the unit from being raised above 20° if the powerhead is operated above approximately 2000 rpm.

When the port side trim cylinder is fully extended, a check valve opens allowing the system to be regulated at 425 psi. If the powerhead exceeds 2000 rpm, the propeller thrust is sufficient to build up pressure above 425 psi on the "up" side of the system.

At this point, excess fluid is returned to the reservoir through a check valve, lowering pressure in the system. When the pressure is reduced, the outboard unit will be lowered to the trim limit position. In this manner, the check valve is operating as a tilt limit switch preventing the outboard unit from being operated at a greater angle than the 20° trim limit, **IF** powerhead rpm exceeds 2000.



*The System "B" is pressurized! Therefore, heed the warning decal just below the fill screw and **NEVER** back off the screw unless the outboard unit is in the full **UP** position.*

If powerhead rpm is cut back below 2000 rpm, the maximum angle may be increased above the 20° limit. **HOWEVER**, if powerhead rpm exceeds 2000 rpm, the thrust created by the propeller -- provided the propeller is deep enough in the water -- will cause the trim system to automatically lower the unit back to the 20° maximum trim angle.

Trimming Outboard Unit DOWN

Depressing the **DOWN** button will close the "down" circuit and actuate the "down" solenoid. The electric motor will operate in the opposite direction (from the "up" direction), forcing hydraulic fluid into the "down" side of the tilt cylinder. This action will move the outboard unit downward. When the desired angle of trim is obtained the button is released and movement ceases.

Trailering

Depress the **UP** button. This action will close the **UP** circuit and activate the **UP** solenoid. The two trim cylinders will extend slowly to the full trim up position. Hold the **UP** button depressed and the tilt cylinder will continue to move the outboard unit upward to the full up position for trailering.

SAFETY WORDS

As a safety measure to prevent accidental movement of the outboard while trailering to and from the water, it is **STRONGLY** recommended a trailer bracket **ALWAYS** be used to mechanically lock the outboard unit in the up position. Such a bracket may be purchased at modest cost from the local marine store. With the bracket in place, the unit may be trailered with confidence over rough roads without fear of the outboard being suddenly jarred to the "down" position.

HYDRAULIC "BLEEDING" SYSTEM "B"

This trim/tilt system with two small trim cylinders and one large tilt cylinder is almost a "self bleeding" system. Actually, the "bleed" operation is accomplished through the fill screw.

Checking For Air In The System

To check for air in the system, first activate the **UP** circuit and raise the outboard slightly

with the trim cylinders. Next, exert a heavy, steady, downward force on the lower unit.

If the trim pistons retract into the trim cylinders more than 1/8" (3.2 mm), the system contains air which must be removed -- allowed to escape.

WARNING

THE TRIM/TILT SYSTEM IS PRESSURIZED. DO NOT REMOVE THE FILL SCREW UNLESS THE OUTBOARD UNIT IS IN THE FULL UP POSITION. NEVER ATTEMPT TO MOVE THE OUTBOARD UNLESS THE FILL SCREW IS SECURELY TIGHTENED.

Raise the outboard unit to the full **UP** position. All three pistons will be fully extended. Once the unit is in the full up position, release the button and engage the tilt lock lever. Now, momentarily depress the **UP** button just a couple times. Depressing the **UP** button, for a second or two, will send current through the **UP** solenoid to the electric motor; the motor will drive the pump; air in the pump will cause it to "squeal"; the pump will draw fluid from the reservoir; the pump will attempt to send fluid to the tilt cylinder; the piston cannot move because it is already extended; the pressure will increase to 425psi (2930 kPa); the port side pressure relief valve will automatically open; the excess fluid will be returned to the reservoir, purging the system of air. Actually, the air is returned to the reservoir.

At this time, **SLOWLY** remove the fill screw and the trapped air will escape. Add fluid, if necessary.

UNDERSTAND, a small amount of air will remain on top of the reservoir under the cap. This is caused by the design of the cap and reservoir and as a "cushion" for the system.

Remove the tilt lock lever; depress the **DOWN** button; lower the outboard unit to the full down position. Now, momentarily depress the **DOWN** button for just a second or two, a couple of times. Depressing the **DOWN** button for a second or two will again activate the system; air in the pump will cause it to "squeal"; the pump will draw fluid from the reservoir; the pump will attempt to send fluid to the "down" side of the tilt cylinder; the cylinder cannot move because it is already retracted; the pressure will increase to 425psi (2930 kPa); the pressure relief valve in the port side trim piston will automatically open; the excess fluid will be returned to the reservoir, purging the system of air. Actually, the air is returned to the reservoir.

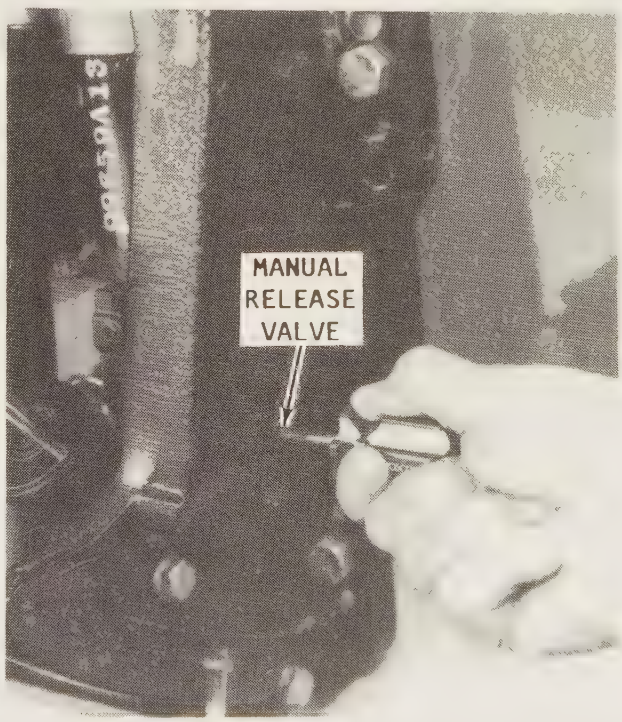
Raise the outboard to the full up position again. Engage the tilt lock lever. **SLOWLY** remove the fill screw again and the trapped air will escape. Add fluid, if necessary.

Repeat the above procedure two or three times and any and all excess air will be bled from the system. After the air leaves the system, a noticeable change in the sound of the pump motor laboring with the outboard unit in the full up or down position will be heard.

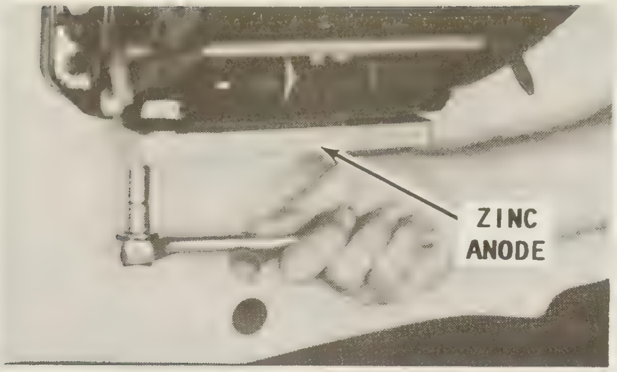
As a further check, make the initial test for air again by first raising the outboard with the trim cylinders just a few degrees, and then exerting a steady downward pressure on the lower unit. If the trim rods do not retract into the cylinders more than about 1/8" (3.2 mm), all excess air has been bled from the system.

HYDRAULIC FLUSHING

Only Automatic Transmission fluid should be used in the power trim system. However, in remote areas or in an emergency, a substitute can be used. SAE 10W-30 or 10W-40 oil rated



The manual release valve is used to release pressure in the system to permit raising the outboard manually. Always release the valve SLOWLY.



The zinc anode must be removed to gain access to the Allen screw for draining the system.

SE was recommended in the past by the manufacturer for earlier model systems. Therefore, these oils should be a workable substitute until the automatic transmission fluid can be obtained. Once the transmission fluid is available, the system **MUST** be flushed of the oil before putting the system into service. This can be accomplished by simply draining all the oil from the system.

First, raise the outboard unit to the full up position and engage the tilt lock lever. Place a suitable container under the starboard side trim cylinder. Next, **SLOWLY** remove the fill screw and bleed the pressure from the system. Back off the manual release valve about two full turns **COUNTERCLOCKWISE** to release any remaining pressure in the system.

Next, remove the two bolts securing the zinc anode to the underneath side of the transom bracket, and then remove the anode.

Now, remove the Allen plug from the underneath side of the starboard trim cylinder and drain the oil from the system.

After all oil has been drained from the system, install the Allen plug; tighten the manual release valve full **CLOCKWISE**; and then add Automatic Transmission Fluid to the system.

"Bleed" air from the system according to the procedures beginning on Page 10-6.

Operate the system several times through the complete cycle from the full down position to the full up position.

Drain this first quantity of flushing transmission fluid according to the foregoing procedures. As the fluid is being drained, take special note of the fluid color. If the fluid has a decided crimson tone, the oil has been flushed from the system. However, if the fluid color has a slight brownish tinge, there is still oil in the system. Repeat the flushing procedure until the brownish tinge has disappeared. The system is now thoroughly flushed and ready for service.

TROUBLESHOOTING SYSTEM "B"

SPECIAL WORDS

When moving through the listed troubleshooting procedures, **ALWAYS** stop and check the system after each task. The problem may have been corrected, intentionally or not.

PRELIMINARY CHECKS

1- Check to be sure the manual release valve, located on the starboard transom bracket, is fully tightened, **CLOCKWISE.**

2- Verify the hydraulic reservoir is filled with fluid. Fluid should be visible when the fill cap is removed. Replenish as required.

WARNING

THE TRIM/TILT SYSTEM IS PRESSURIZED. DO NOT REMOVE THE FILL SCREW UNLESS THE OUTBOARD UNIT IS IN THE FULL UP POSITION. NEVER ATTEMPT TO MOVE THE OUTBOARD UNLESS THE FILL SCREW IS SECURELY TIGHTENED.

3- Inspect the hydraulic system fittings for leaks. If an external leak is discovered, correct the condition.

4- Check for air in the system and bleed-off if air is suspected.

To check for air in the system, first activate the **UP** circuit and raise the outboard slightly with the trim cylinders. Now, exert a heavy, steady, downward force on the lower unit.

If the trim rods retract into the trim cylinders more than 1/8" (3.2 mm) there is air in the system.

Raise the outboard unit to the full **UP** position three or four times. Each time the unit is in the full **UP** position, engage the tilt lock lever, and then **SLOWLY** remove the fill screw. Add fluid, if necessary.

In this manner any air in the system is forced out through the fill screw opening.

5- If the system fails to hold the outboard unit in the full tilted (trailering) position, service the port side trim rod from the

cylinder. To remove, service, and install either trim cylinder, see the instructions beginning on Page 10-29.

CRITICAL WORDS

DO NOT remove the check valve from the port side trim rod. (The starboard rod does not have a check valve.) This check valve has been preset at the factory to operate at a specific pressure. Therefore, removal and installation of the check valve could result in improper operating pressure and possible damage to the system.

After the rod has been removed, inspect the check valve for any foreign material and clean, as required. If the check valve cannot be cleaned satisfactorily, the trim rod and check valve **MUST** be replaced as a unit.

While the rod is out of the cylinder, inspect the **O**-ring and replace it with a new one, if there is any sign of damage.

6- Inspect the manual release valve **O**-ring and the valve for damage. To remove, service, and install the manual release valve, see instructions on Page 10-42.

7- If the tilt cylinder fails to raise the outboard unit to the full **UP** position or fails to move the unit downward properly, the tilt cylinder requires attention. To remove, service, and install the tilt cylinder, see instructions beginning on Page 10-34.

8- If the pump "whines" during operation, there is probably air in the system. "Bleed" the system according to the procedures beginning on Page 10-20.

9- If the motor makes "strange" sounds or seems to be "laboring", see Chapter 7 to service the electric motor.

SPECIAL WORDS

If a problem is encountered with the trim/tilt system, it is important to determine, if possible, whether the malfunction is in the hydraulic system or in an electrical circuit.

SYMPTOMS OF HYDRAULIC PROBLEM

The most common problem in the hydraulic system is failure of an **O**-ring to hold pressure. Therefore, if any of the following problems are encountered, see the service instructions beginning on Page 10-29.

a- Outboard will not rim up or down. Fluid level low; manual release valve not fully closed; pump failure; **O**-rings in trim cylinders or in tilt cylinder damaged.

b- Outboard trims up, but will not trim down. Tilt cylinder requires service.

c- Outboard trims down, but will not trim up. Trim cylinders require service.

d- Outboard "shudders" when shifted from one gear to another. Air in the system; internal cylinder leaks -- **O**-rings failure to hold pressure.

e- Outboard fails to hold set trim position or will not hold tilted position. **O**-rings in trim and tilt cylinder fail to hold pressure; internal check valve on port cylinder requires cleaning; external leak --fitting or part.

f- Outboard begins to trail out (starts to rise slightly) when throttle is backed-off from high speed. Manual release valve not fully closed; air in the system; **O**-ring/s in tilt cylinder fail to hold pressure.

g- Outboard fails to hold trim position when unit is operating in reverse gear. Manual release valve not fully closed; **O**-rings in trim cylinders fail to hold pressure.

h- Outboard fails to return to complete down position or returns partially with jerky motion; air in the system; internal leaks in the cylinders.

SYMPTOMS OF ELECTRICAL PROBLEM

If any of the following problems are encountered, troubleshoot the electrical system as outlined in this section.

a- Outboard trims up and down, but the electrical motor "grinds".

b- Outboard will not trim up or down.

c- Outboard trims up, but will not trim down.

d- Outboard trims down, but will not trim up.

Manual Operation

If the battery is dead, or sufficient power cannot be supplied to the electric motor to drive the hydraulic pump for any number of reasons, the outboard unit may be raised manually.

WARNING

IF OUTBOARD UNIT IS IN THE UP POSITION WHEN THE MANUAL RELEASE VALVE IS OPENED, THE OUTBOARD WILL DROP TO THE FULL DOWN POSITION RAPIDLY. THEREFORE, ENSURE ALL PERSONS STAND CLEAR.

Rotate the manual release valve three to four complete turns **COUNTERCLOCKWISE.**

If the outboard unit is in the down position, it may be raised manually for trim or for trailering. If the unit is in the up position, the unit will drop **RAPIDLY** to the full down position.

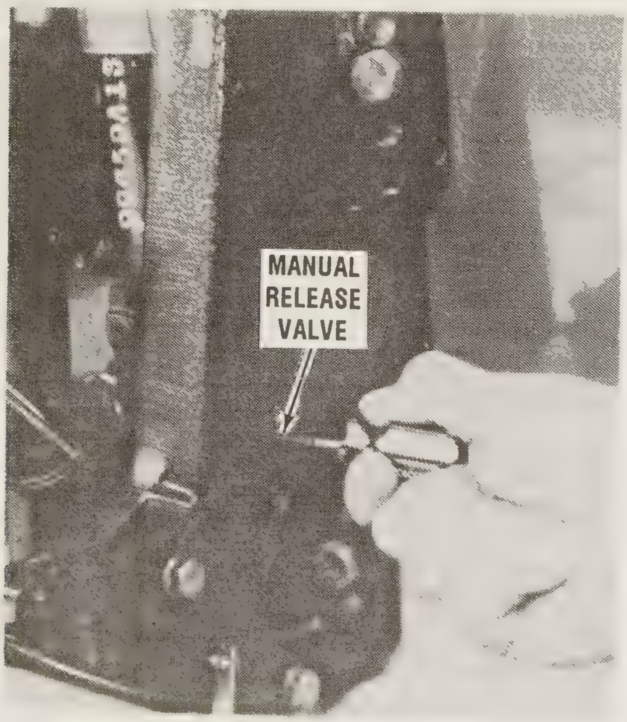
PUMP MOTOR TEST SYSTEM "B"

This simple procedure will determine if the pump motor requires service.

a- Disconnect the **Blue** motor wire from the **UP** solenoid. Disconnect the **Green** motor wire from the **DOWN** solenoid. Disconnect the **Black** motor ground wire.

b- Connect a test lead from the positive terminal of a 12-volt battery to the **Blue** wire just removed from the solenoid. Connect a test lead from the negative (-) terminal of the battery to the **Black** ground wire disconnected. The motor should run. Leave the ground wire connected, and change the positive (+) battery lead to the **Green** wire removed from the **DOWN** solenoid. The motor should run. If the motor fails either one or both of these tests, it requires service or replacement.

To remove and install a System "**B**" motor or pump, see instructions beginning on Page 10-



*Releasing pressure by backing out the manual release valve **SLOWLY** three or four complete turns.*

29. The System "**B**" pump **CANNOT** be serviced. Therefore, if the pump has failed, it **MUST** be replaced.

ELECTRICAL SYSTEM TROUBLESHOOTING SYSTEM "B"

SPECIAL WORDS

When moving through the listed electrical troubleshooting procedures, **ALWAYS** stop and check the system after each task before proceeding with further troubleshooting. The problem may have been corrected, intentionally or not.

"TRAILER" CIRCUIT INOPERATIVE "UP" CIRCUIT OK

1- With an ohmmeter on the Rx1 scale, check for continuity between the "small" terminal on the lower solenoid (the terminal with the **Blue/White** wire connected), and the **TRAILER** button terminal with the **Blue/White** wire connected. If continuity is not indicated, the wire is open.

2- If the wire checked OK in Step 1, disconnect all battery leads from the battery. Check for continuity across trailer button terminals with trailer button depressed. If continuity is **NOT** indicated, the trailer button is at fault and must be replaced.

"UP" AND TRAILER CIRCUITS BOTH INOPERATIVE "DOWN" CIRCUIT OK

BEFORE spending time with a voltmeter and making other tests, check **ALL** connections on the **UP** solenoid and all other wiring for loose or corroded connections, frayed insulation, or a break in a wire.

1- Connect the **Red** voltmeter lead to the "small" terminal of the lower solenoid (terminal with the **Blue/White** wire connected). Connect the **Black** voltmeter lead to the ground terminal of the bottom solenoid (the terminal with the **Black** lead connected). Depress the **Trailer** button.

If **NO** voltage is indicated, there is an open circuit in the **Blue/White** wire and **Purple/White** (or **Purple**) wires between the **UP** solenoid and the trim buttons.

If voltage **IS** indicated, proceed with Step 2.

2- Leave the **Black** meter lead connected to

ground, as in Step 1. Connect the **Red** meter lead to the large terminal with two **Red** leads connected on the lower solenoid.

If **NO** voltage is indicated, check for loose or corroded connection at the "large" terminal with the two **RED** leads connected on the lower solenoid.

Also check for loose connection or corrosion at the same terminal on the upper solenoid. Check the condition of the **RED** lead connecting these two terminals of each solenoid together.

If voltage **IS** indicated, proceed with Step 3.

3- Leave the **Black** voltmeter lead connected to ground as in Steps 1 and 2. Connect the **RED** voltmeter lead to the "small" terminal of the lower solenoid (the terminal with the **Black** wire connected).

Depress the **TRAILER** button. If **NO** voltage is indicated, the lower solenoid (the **UP** solenoid) is defective and must be replaced.

If voltage **IS** indicated proceed with Step 4.

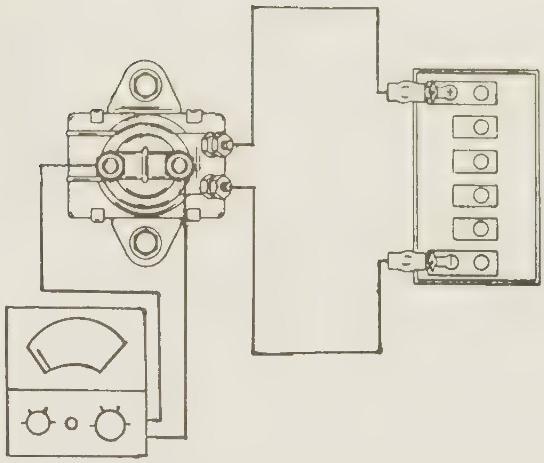
4- Inspect the lower solenoid (the **UP** solenoid), for loose or corroded connections. Remove the lower mounting bolt on the lower solenoid and check for paint, grease, dirt, corrosion, and the like preventing the connecting wire from making a good ground. Install the bolt.

If the **UP** and **TRAILER** circuits still do not function, disconnect the battery leads at the battery. Label the wires leading to the lower solenoid, or draw a quick sketch before disconnecting any of the leads. Remove all connections leading to the solenoid and remove the two attaching bolts. Bench test the solenoid according to the following procedures.

Solenoid Bench Tests

a- Connect a 12-volt battery across the two smaller terminals. The ohmmeter should register 0-ohms (zero) indicating continuity and an audible "click" should be heard. The "click" sound will verify the plunger in the solenoid is being drawn up making contact with the inside terminal to close the circuit.

b- If the ohmmeter indicates a resistance in the solenoid and/or a "click" sound is not heard, the solenoid is defective and **MUST** be replaced.

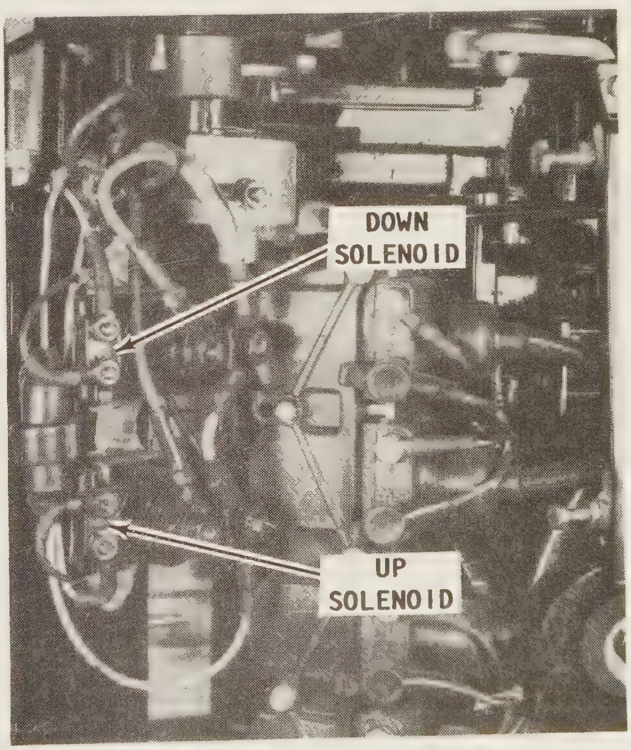


Schematic drawing to show the hookup using a 12-volt battery supply and ohmmeter to test the solenoid, as described in the text.

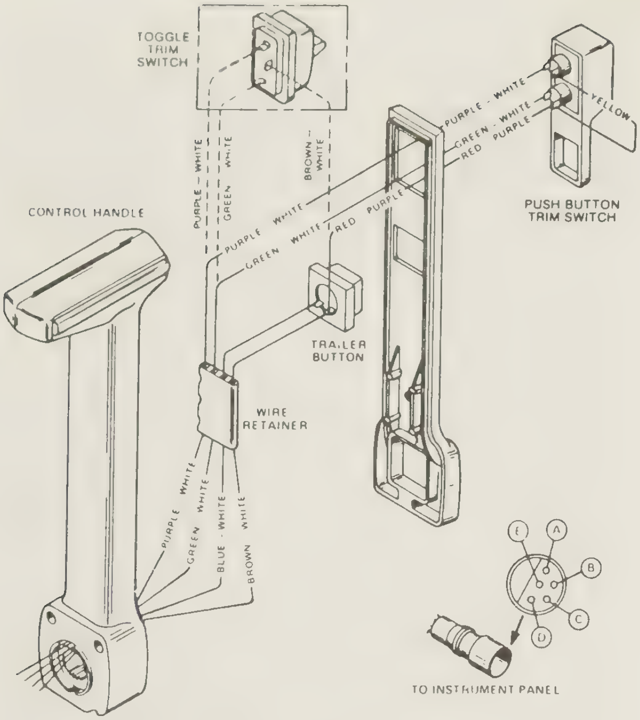
If the solenoid checked OK, test the charge condition of the battery and inspect all cables and leads.

UP CIRCUIT INOPERATIVE TRAILER CIRCUIT OK

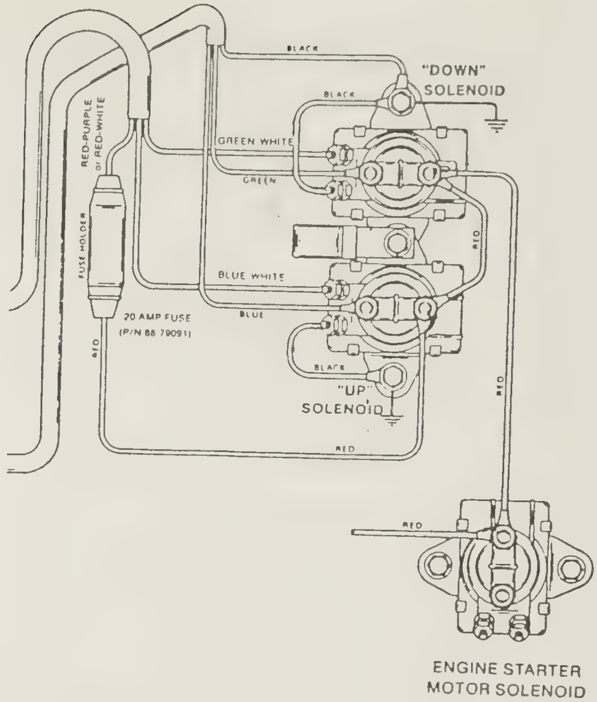
BEFORE spending time with a voltmeter and making other tests, check **ALL** connections on the **UP** solenoid and all other wiring for loose or corroded connections, frayed insulation, or a break in a wire.



*Solenoid installation on the powerhead. The top solenoid controls the **DOWN** movement and the lower solenoid controls the UP movement.*



Exploded drawing of the control handle. This illustration and the wiring diagram in the next column will be helpful during the troubleshooting work.



Functional diagram of the System "B". This drawing and the one in the left column will be helpful during the troubleshooting work.

1- With an ohmmeter on the Rx1 scale, check for continuity between the "small" terminal on the lower solenoid (the terminal with the **Blue/White** wire connected). If continuity is **NOT** indicated, there is an open wire in the circuit between these two connections.

If continuity **IS** indicated, proceed with Step 2.

2- If a push button type switch is being tested connect the **RED** voltmeter lead to the **UP** button on the trim switch (the terminal with the **YELLOW** wire connected). If a toggle switch is being tested, connect the **RED** voltmeter lead to the center terminal (the terminal with the **Brown/White** or **Red/Purple** wire connected).

Connect the **Black** voltmeter lead to a good ground such as the mounting bolt of the lower solenoid.

Depress the **UP** trim button. If **NO** voltage is indicated, the trim switch is defective and must be replaced.

If voltage **IS** indicated, proceed to Step 3.

3- Check for poor or corroded connections at the **UP** button or toggle switch.

If the **UP** circuit is still inoperative, replace the **UP** button or switch.

DOWN, UP, AND TRAILER CIRCUITS INOPERATIVE

BEFORE spending time with a voltmeter and making other tests, check **ALL** connections on both solenoids and all other wiring for loose or corroded connections, frayed insulation, or a break in a wire.

1- Check the two 20 amp in-line fuses, as shown in the two accompanying illustrations.

Replace the defective fuse and again test the **UP**, **DOWN**, and **TRAILER** operation of the trim/tilt system. If the fuses were not "blown", proceed with Step 2.

2- Connect the **RED** lead of a voltmeter to the "large" terminal of the lower solenoid (the terminal with the two **Red** wires connected). Connect the **Black** lead of the voltmeter to the "small" terminal of the lower solenoid (the terminal with the **Black** wire connected).

The voltmeter should indicate close to 12-volts.

If **NO** voltage is indicated, check the battery leads and the **Red** leads between the starter motor and the "large" terminal on the upper solenoid (the terminal with 2 **Red** wires connected) and the same terminal on

the lower solenoid (the terminal with the two **Red** wires connected). Check for poor connections, corrosion or an open circuit.

If battery voltage **IS** indicated, proceed to Step 3.

3- Leave the **Black** voltmeter lead connected to ground as in Step 2. Connect the **Red** voltmeter lead to the "small" terminal on the lower solenoid (the terminal with the **Blue/White** wire connected.

Depress the **TRAILER** button and check for close to 12-volts. If battery voltage is indicated, check the **Black** ground wires at the solenoids (the upper and lower mounting bolts with **Black** wires attached.) **PARTICULARLY** the **Black** motor lead from the harness, grounded at the top mounting bolt.

If this wire is properly grounded, and circuits are still inoperative, the pump motor may be faulty. Refer to Chapter 7 for troubleshooting electric motors.

If **NO** voltage is indicated, proceed to Step 4.

4- Leave the **Black** voltmeter lead connected to ground as in Step 2 and 3. Connect the **Red** voltmeter lead to the **TRAILER** button (the terminal with the **Brown/-White** and **Red/Purple** wires connected).

If battery voltage **IS** indicated, there is an open circuit in each wire. **(Green/White, Blue/White**, and **Purple/White**), between the trim buttons (or toggle switch), and the trim motor. Check for pinched or severed wires and inspect all trim harness connectors for loose or corroded connections.

If **NO** voltage is indicated, proceed with Step 5.

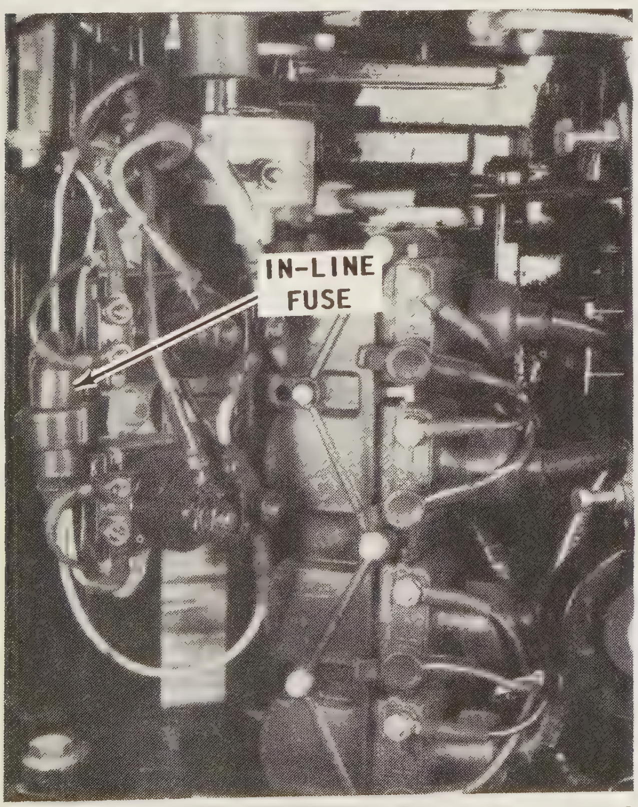
5- Verify voltage is being supplied to the controls by performing the following checks:

a- **DO NOT** start the engine, but turn the ignition switch to the **RUN** position. Use a voltmeter and check for voltage at any instrument.

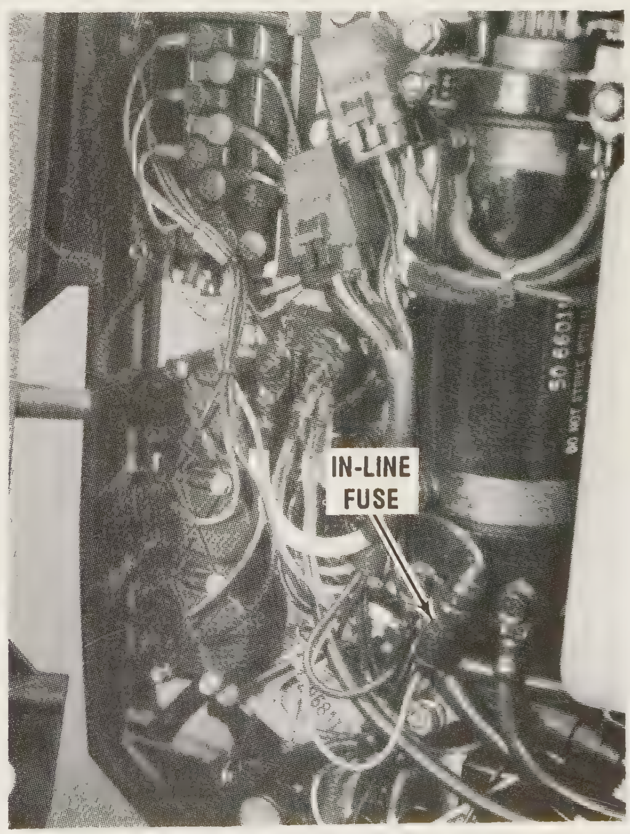
b- If close to 12-volts **IS** indicated, there is an open circuit in the wire between the **TRAILER** button (the terminal with the **Brown/White** and **Red/Purple** wires connected), and the "B" terminal on the back of the ignition switch (the terminal with the **Grey** wire connected), as shown in the accompanying illustration.

c- If **NO** voltage is indicated, proceed to Step 6.

6- Check for continuity between the "large" terminal on the starter solenoid (the terminal with the **Red** wire connected), and the **"B"** terminal on the back of the ignition switch. Check for open wires, loose or corroded connections.



Location of one of two in-line fuses on powerheads equipped with the System "B" Power Trim/Tilt unit.



Location of the other in-line fuse on powerheads equipped with the System "B" Power Trim/Tilt unit.

DOWN CIRCUIT INOPERATIVE UP CIRCUIT OK

BEFORE spending time with a voltmeter and making other tests, check **ALL** connections on the **DOWN** solenoid and all other wiring for loose or corroded connections, frayed insulation, or a break in the wire.

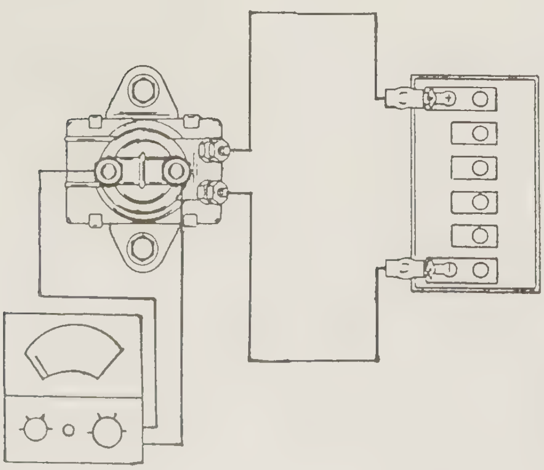
1- Connect the **Red** voltmeter lead to the "small" terminal of the upper solenoid (the terminal with the **Green/White** wire connected). Connect the **Black** voltmeter lead to the top mounting bolt of the upper solenoid (the ground terminal with the **Black** wire connected).

Depress the **DOWN** trim button or toggle switch.

If **NO** voltage is indicated, leave the **Black** voltmeter lead in place and connect the **Red** voltmeter lead to the **DOWN** button (the terminal with the **Green/White** wire connected). Again, depress the **DOWN** button. If close to 12-volts **IS** indicated, there is an open wire between the **DOWN** push button (or toggle switch), and the "small" terminal on the upper solenoid (the terminal with the **Green/White** wire connected).

If **NO** voltage is indicated, proceed with Step 2.

2- Leave the **Black** voltmeter lead connected as in Step 1. Connect the **Red** meter lead to the **DOWN** terminal of the push button (the terminal with the **Red/Purple** wire connected). If testing a toggle switch, connect the **Red** meter lead to the center terminal (the terminal with the **Brown/White** or **Red/Purple** wire connected).



Functional diagram depicting a battery hooked up directly to one of the solenoids for testing.

If close to 12-volts **IS** indicated, the trim switch is faulty and must be replaced.

If **NO** voltage is indicated, check for loose or corroded connections at the testing points in this step. Test the **DOWN** circuit for operation.

If still inoperative, proceed with Step 3.

3- Leave the **Black** voltmeter lead in place as in Step 1 and 2. Connect the **Red** voltmeter lead to the "large" terminal on the upper solenoid (the terminal with the two **Red** wires connected).

If **NO** voltage is indicated, there is an open circuit between this terminal and the positive battery terminal. Check the entire length of the wires for damage to insulation, evidence of sparking, loose or corroded connections.

If close to 12-volts **IS** indicated, proceed with Step 4.

4- Leave the **Black** voltmeter lead connected as in Step 3. Connect the **Red** voltmeter lead to the "small" terminal on the upper solenoid (the terminal with the **Green/White** wire connected). Depress the **DOWN** trim button or toggle switch.

If **NO** voltage is indicated the **DOWN** solenoid is defective and must be replaced. If close to 12-volts **IS** indicated, proceed with Step 5.

5- Tag the wires or make a quick sketch, and then remove the **DOWN** solenoid. Test the solenoid according to the following procedures.

Solenoid Bench Tests

6- The following simple quick test can be performed to check the integrity of the solenoid:

a- Connect a 12-volt battery across the two smaller terminals. The ohmmeter should register 0-ohms (zero) indicating continuity and an audible "click" should be heard. The "click" will verify the plunger in the solenoid is being drawn up making contact with the inside terminal to close the circuit.

b- If the ohmmeter indicates a resistance in the solenoid and/or a "click" is not heard, the solenoid is defective and **MUST** be replaced.

If the solenoid checked "Okay", test the charge condition of the battery and inspect all cables and leads.

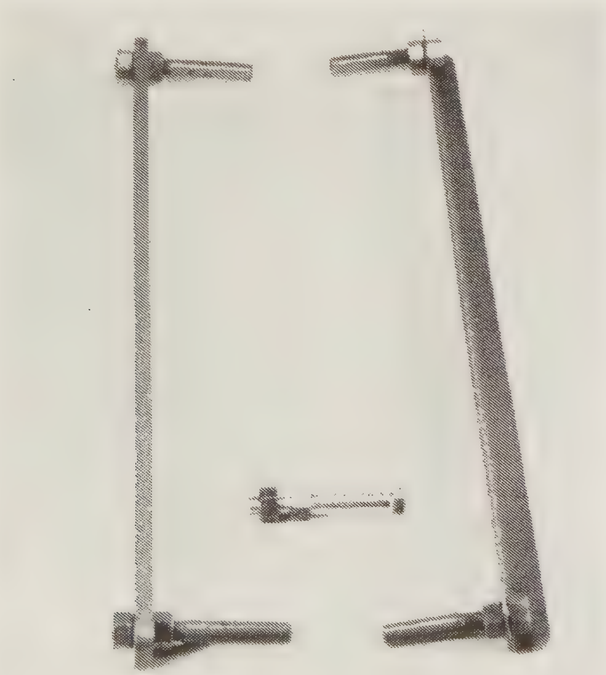
TRIM/TILT SERVICE SYSTEM "B"

The following procedures provide detailed instructions to remove, service, and install various parts of the System "B" Hydraulic Trim/Tilt system. Each small section has a heading to identify the part being serviced.

The hydraulic pump in the System "B" cannot be serviced. Therefore, if troubleshooting leads to a faulty pump, without question, then the unit must be replaced. Other parts, such as the trim cylinders, tilt cylinder, reservoir screen, and electric motor, may be serviced. Some may be removed and/or serviced without disturbing other parts. The trim cylinders, and the large tilt cylinder may be serviced without removing the complete system from the clamp bracket. The pump and electric motor may be removed after the starboard clamp bracket is moved clear.

SAFETY WORDS

As a safety measure to prevent accidental movement of the outboard while work is being performed, it is **STRONGLY** recommended a few minutes be used to make a safety support tool as shown in the accompanying illustration. The tool may be made from any metal bar stock or small channel iron of suitable size, with a 3/8" (9.53 mm) hole drilled through at each end and 14" (35.6 cm) apart, as shown. Cut-off the head of a 3/8" bolt about 2-1/2" (6.4 cm) long. Drill a hole through each bolt for a cotter pin. Secure the bolts through the holes made in the bar stock with two nuts, one on each side of the bar. The tool is now ready for installation, one end through the clamp bracket and the other end through the tilt stop bracket. Secure each end of the tool in place with a washer and cotter pin. The trim/tilt system may now be serviced or other work performed with confidence and in safety.



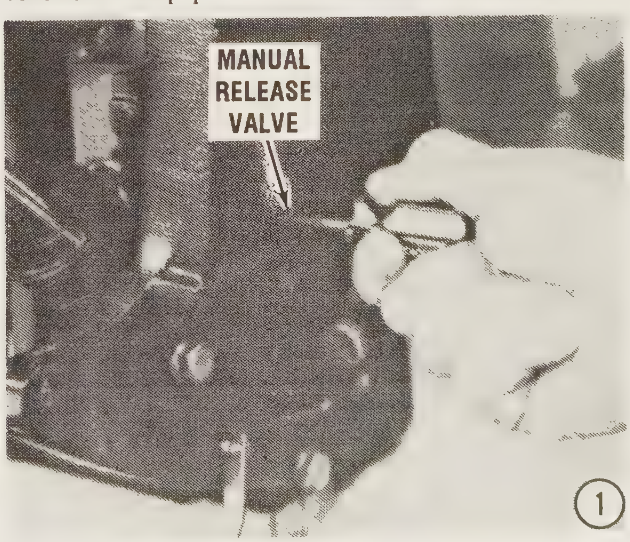
"Home made" safety support tool to hold the outboard in the full up position while performing work on the Power Trim/Tilt unit. The tool can be made from a piece of strap material (left), or a small channel (right), as described in the text.

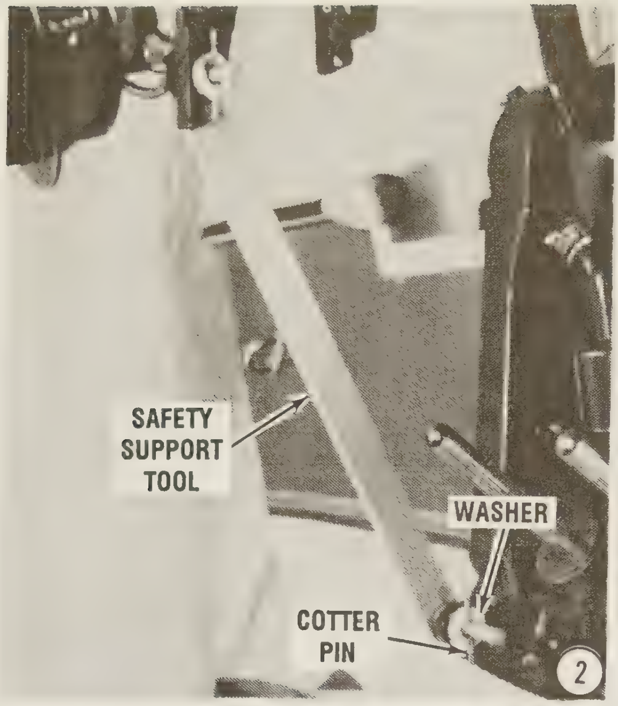
The following procedures outline detailed instructions for removal of the complete trim/tilt system from the outboard unit, disassembling as far as practical of each major part, cleaning and inspecting, assembling, and installation back on the boat. If the damaged part is discovered, the disassembling work may be stopped, a replacement installed, the unit assembled, and installed between the clamp brackets.

TRIM/TILT SYSTEM REMOVAL

PRELIMINARY TASKS

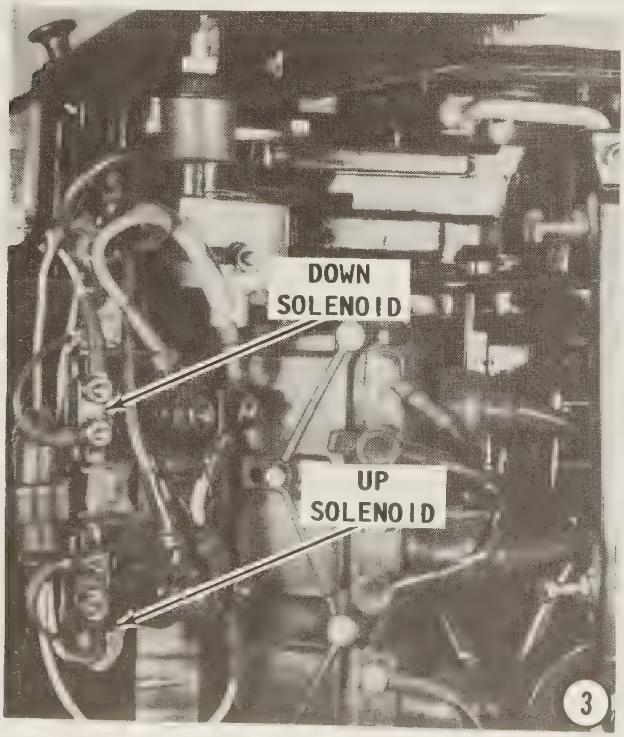
1- Raise the outboard unit to the full up position. If the hydraulic system is inoperative, first rotate the manual release valve **COUNTERCLOCKWISE** about three complete turns, and then manually lift the unit to the full up position.

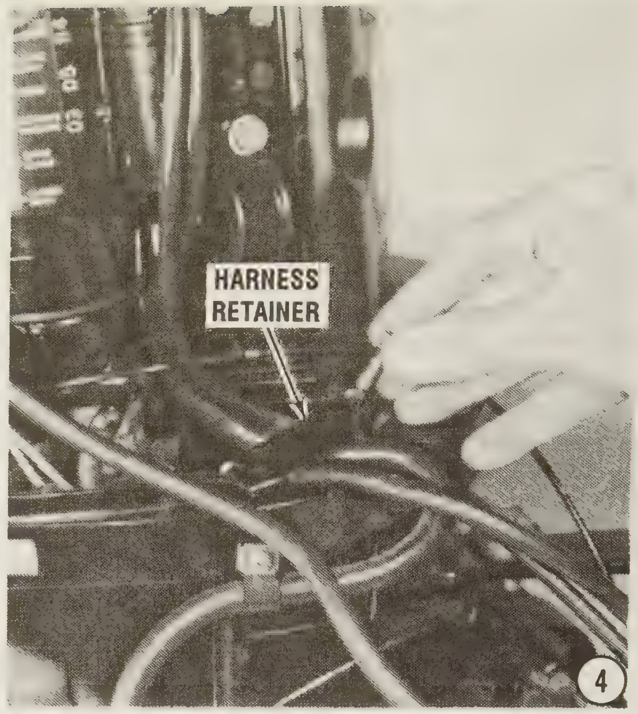




2- Set the tilt lock lever in place. Install the safety support tool as described under "Safety Words" at the beginning of this section. Secure one end of the tool to the clamp bracket with a washer and cotter pin. Secure the other end to the tilt stop bracket in a similar manner, as shown.

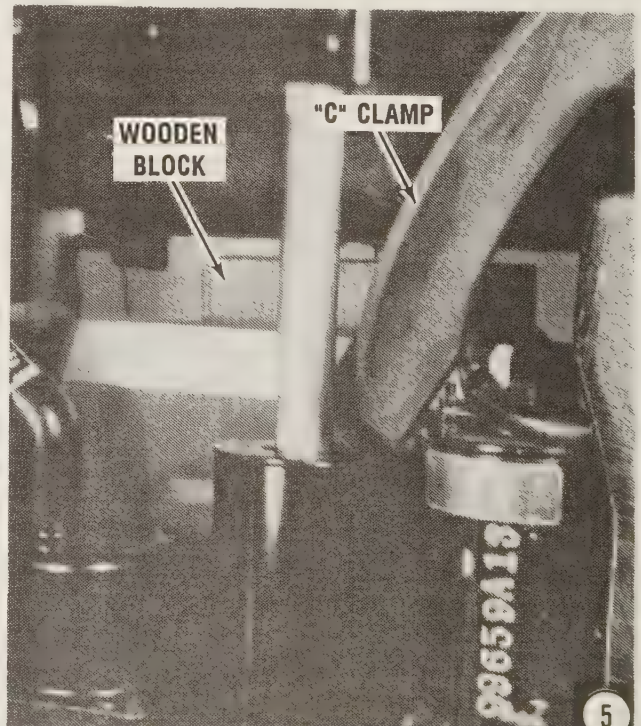
3- Disconnect the electrical cables at both battery terminals. Tag, and then disconnect the wiring at the upper and lower solenoids under the powerhead cowling.

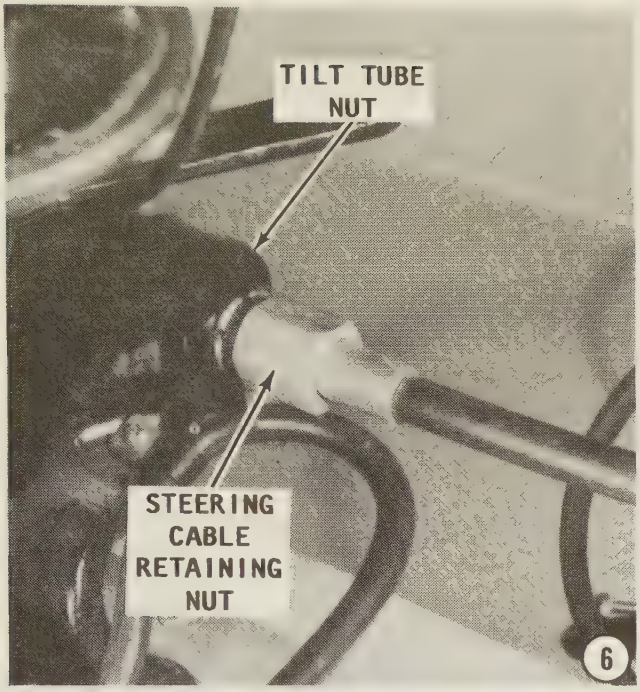




4- Remove the harness retainer and any other clamps securing wiring running to the electric motor.

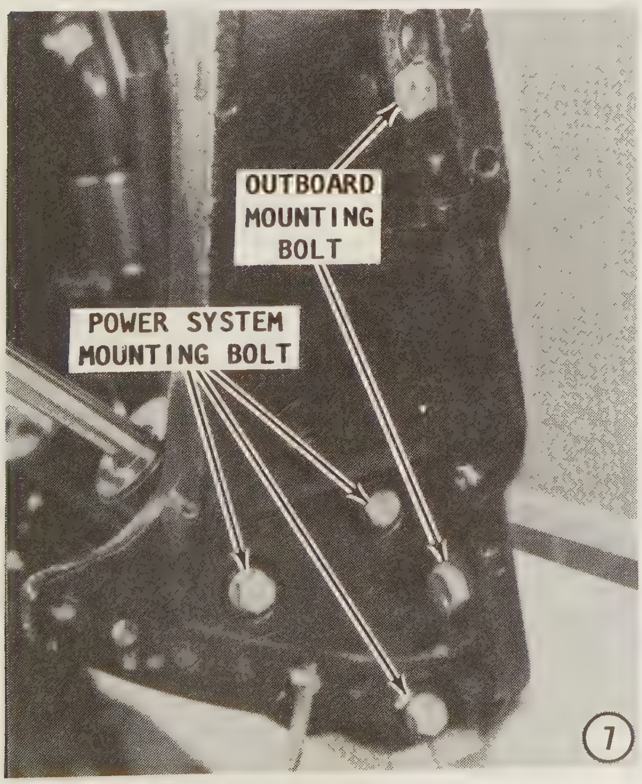
5- Obtain a large C-clamp and a block of wood, approximately 4" to 6" (10.2 x 21.2 cm) square and about 2" (5.1 cm) thick. Support the outboard unit by clamping the block of wood on the inside of the transom up hard against the swivel bracket tube with the large C-clamp, as shown.

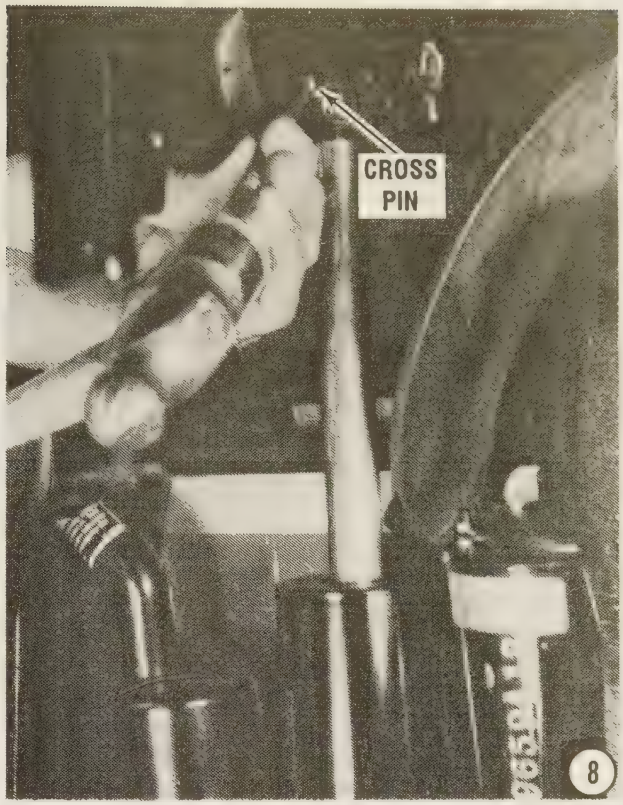




6- If the unit being serviced is equipped with thru-the-tilt tube steering, remove the steering cable retaining nut from the end of the tilt tube. Remove the tilt tube nut.

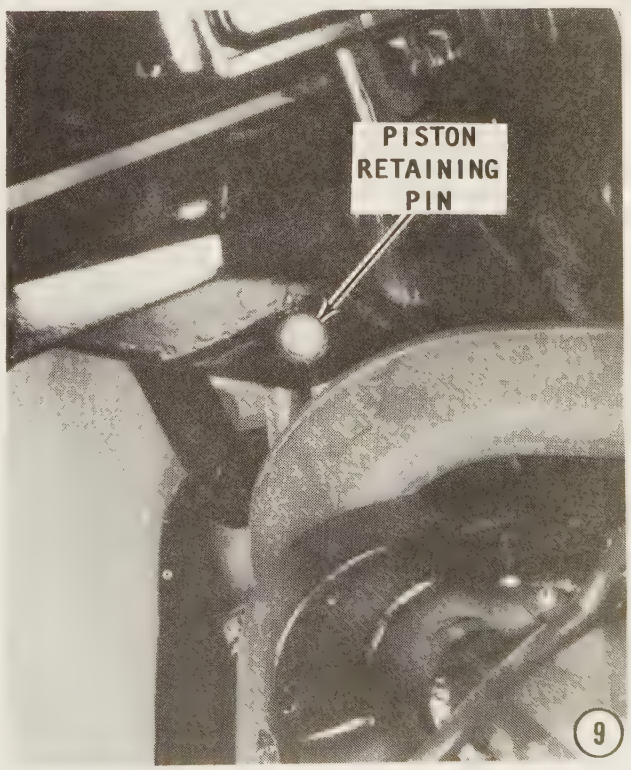
7- Remove the two outboard mounting bolts and the three bolts securing the trim/-tilt assembly to the starboard bracket. Carefully move the starboard transom bracket away far enough for the manual release valve to clear when the trim/tilt system is removed.





8- Drive out the cross pin securing the retaining pin for the tilt piston at the upper end. The cross pin should **NEVER** be used a second time.

9- After the cross pin is free, push out the piston retaining pin. **DO NOT** allow the cylinder to fall free.



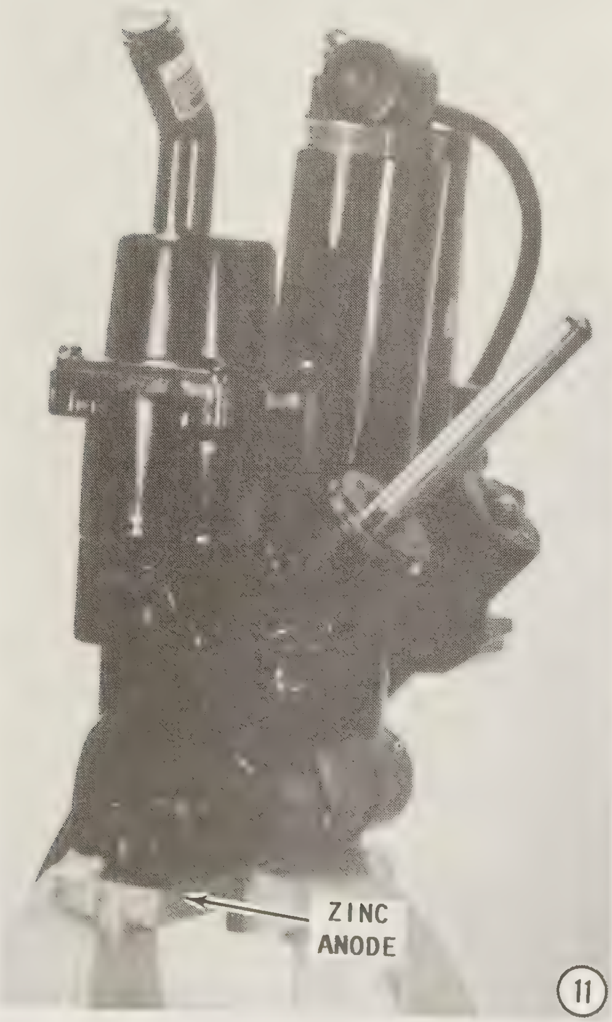
10

10- Support the trim/tilt system. Remove the three mounting bolts securing the system to the port side clamp bracket. Lower the system from the outboard unit. Pull the wires out with the system.

11- Clamp the trim/tilt system in a vise with the jaws gripping on the anode installed on the underneath side of the system.

GOOD WORDS

The system is now ready for any and all work necessary to restore the trim/tilt unit to satisfactory performance.



11

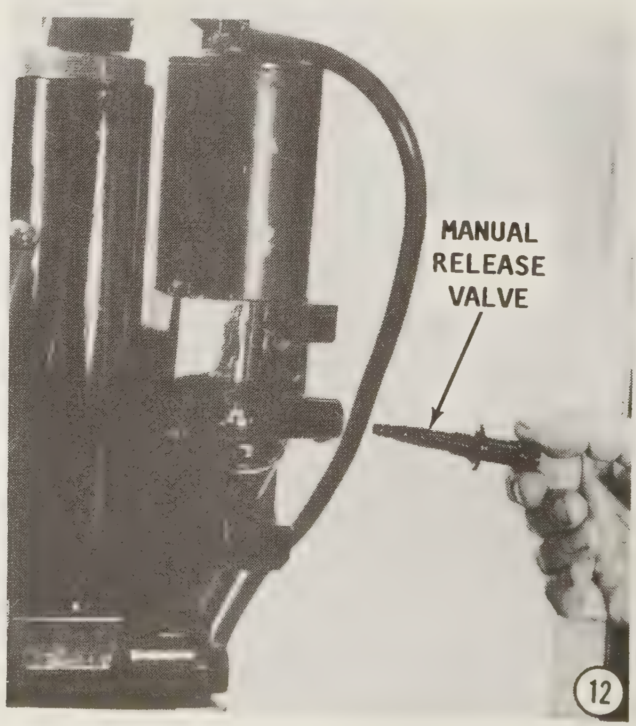
MANUAL RELEASE VALVE

FIRST, THESE WORDS

Only on rare occasion, would the manual release valve need to be removed and serviced. The most probable cause might be the attack of varnish in the hydraulic fluid on the O-rings. Any moisture in the fluid would also be harmful to the O-rings. There is a remote possibility the passageway of the valve may require cleaning.

FIRST, perform PRELIMINARY Steps 1 thru 7 of this section.

12- After the starboard clamp bracket is clear or the complete system removed, then back out the manual release valve by rotating it **COUNTERCLOCKWISE** until it is free and can be withdrawn.



12

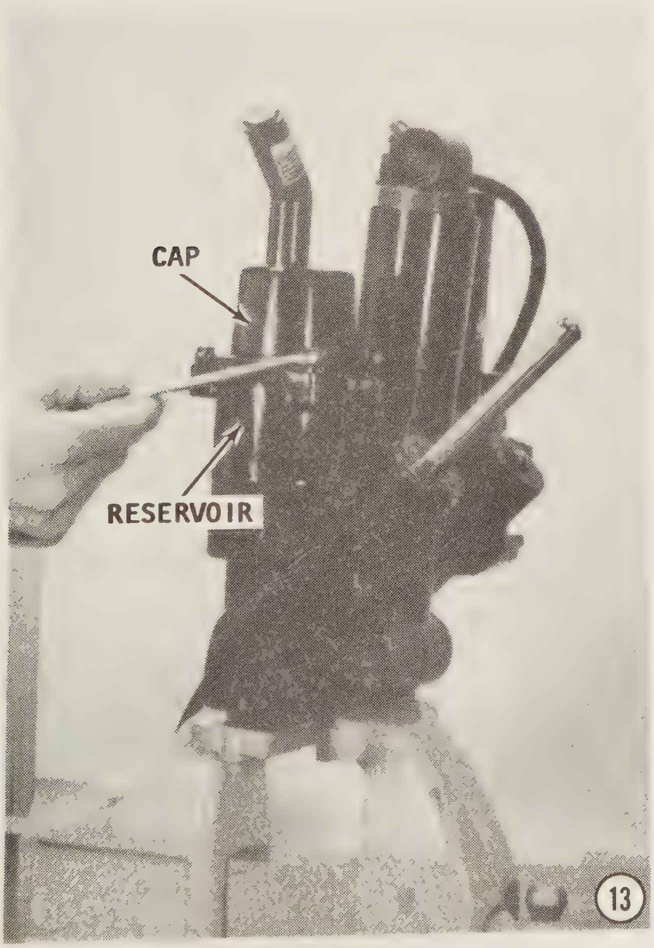
OIL RESERVOIR COVER

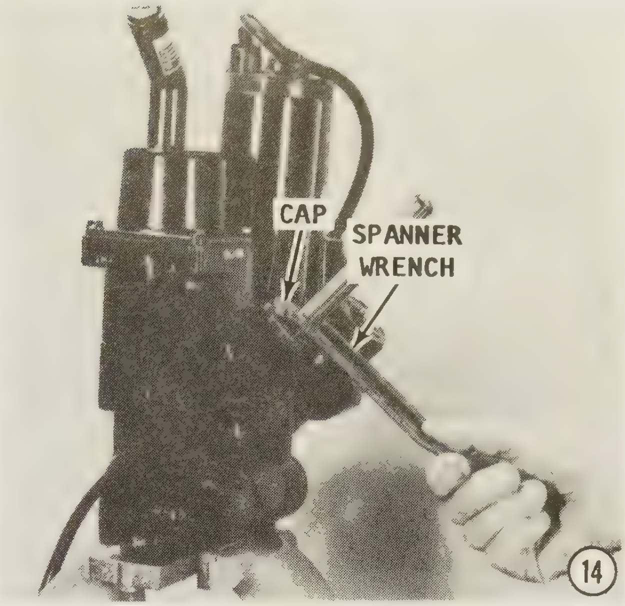
The reservoir cover would only be removed if there is evidence the O-ring is leaking (fluid weeping from around the cover), or a suspicion exists the fluid is contaminated. The cover may be removed with the system still installed on the clamp brackets.

An air gap exists in the reservoir cover as a "cushion" for the system. Therefore, very little fluid will be spilled when the cover is removed.

13- If the system has not been removed from the clamp brackets, perform PRELIMINARY Steps 1 thru 7 of this section. After all pressure has been released, remove the bolts securing the cap to the reservoir. (The accompanying illustration was taken with the system removed from the clamp bracket.) Use the proper size socket with an extension to reach the bolts on the back side.

Lift the cap free of the reservoir. The filler tube and the cover are a one piece unit. Therefore, rotate the filler tube in the clamp bracket hole, and then withdraw the tube from the bracket.





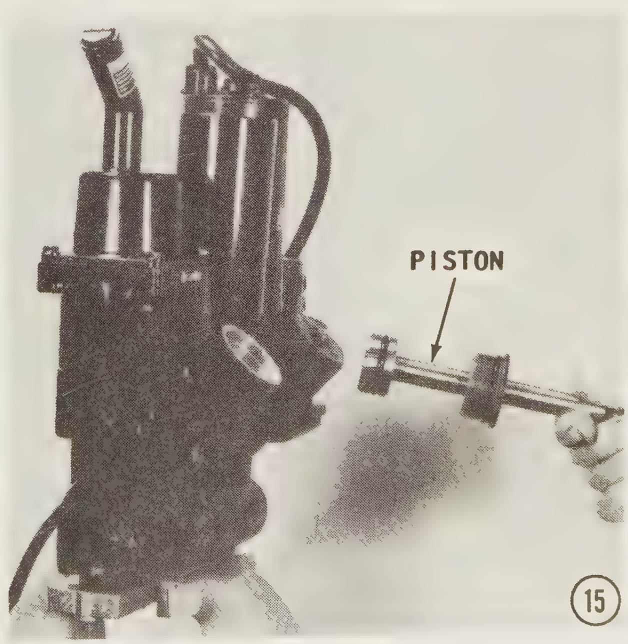
TRIM CYLINDER SERVICE PORT OR STARBOARD

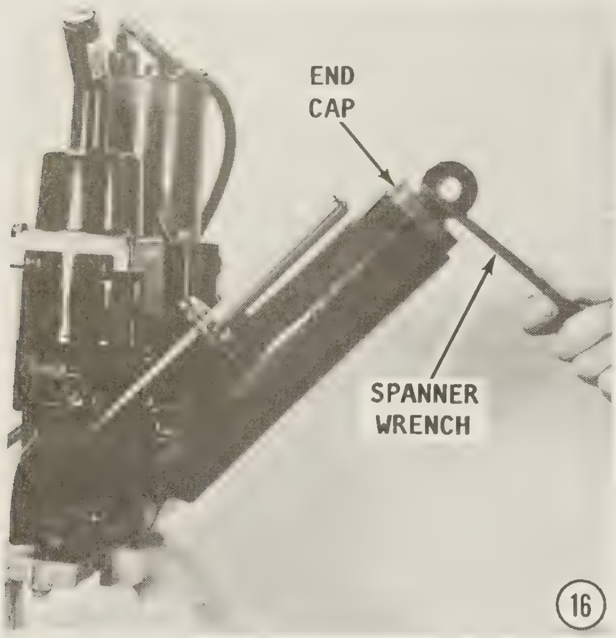
SPECIAL WORDS

If either or both of the trim cylinders are to be serviced without removing the system from the clamp brackets, perform PRELIMINARY Steps 1 and 2 of this section.

14- Using a spanner wrench with the two tips indexed into the two recesses in the cylinder end cap, remove the end cap by rotating the cap in a counterclockwise direction until it is free.

15- After the end cap is free, carefully withdraw the piston straight up and out of the cylinder.





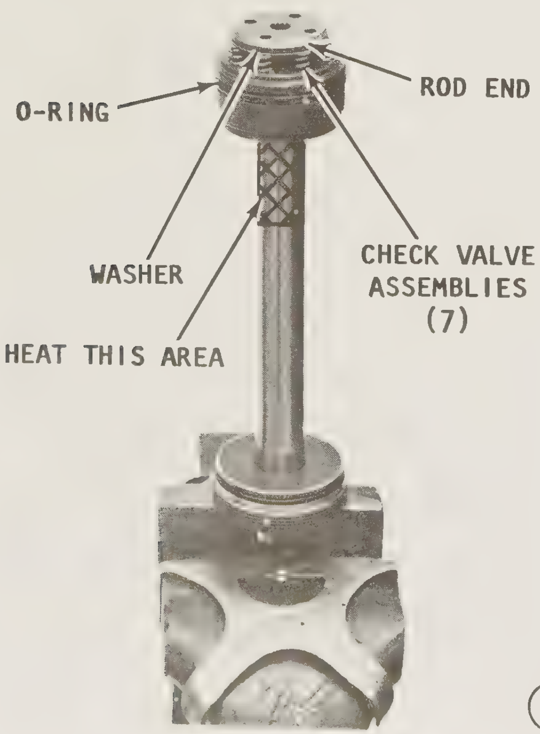
16

TILT CYLINDER SERVICE

SPECIAL WORDS

If the tilt cylinder is to be serviced without removing the system from the clamp brackets, perform PRELIMINARY Steps 1 and 2 of this section.

16- Remove the end cap using a spanner wrench with the points indexed into the recesses of the end cap. Rotate the end cap **COUNTERCLOCKWISE** until it is free of the cylinder.



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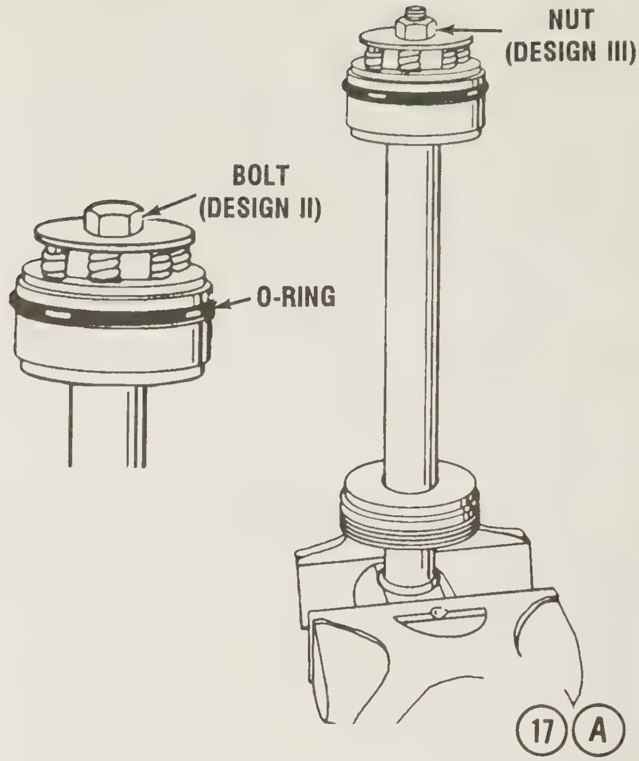


17 A

Carefully pull the piston and rod assembly straight out of the cylinder, with the end cap on the piston rod.

17- Clamp the rod in a vise equipped with soft jaws with the jaws gripping the upper end. Tighten the vise **JUST** good and snug to prevent any possible damage to the piston end. Remove the rod end using a spanner wrench and rotating the rod end **COUNTERCLOCKWISE** until it is free. If the rod end refuses to loosen, heat may have to be applied to the upper end of the rod **UNDER** the piston.

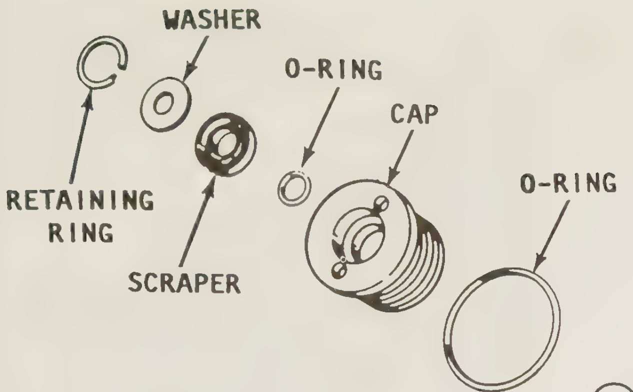
CRITICAL WORDS

Do not let the check valve assemblies fall when removing the rod end, or the washer.

Lift the rod end straight up and out of the piston. Carefully remove the washer, and then the check valve assemblies. Slide the piston free of the rod. If necessary, slide the end cap off the rod.

17A- If the trim/tilt system is equipped with a design II or design III tilt cylinder, perform the following:

Place the rod end into a vise with soft jaws gripping the upper end of the piston. Tighten the vise snug to prevent any possible damage to the upper end. Remove the bolt on (design II) or nut on (design III) rod end. Lift off the washer, O-ring, seven check valve assemblies and the piston. Slide the end cap up and free



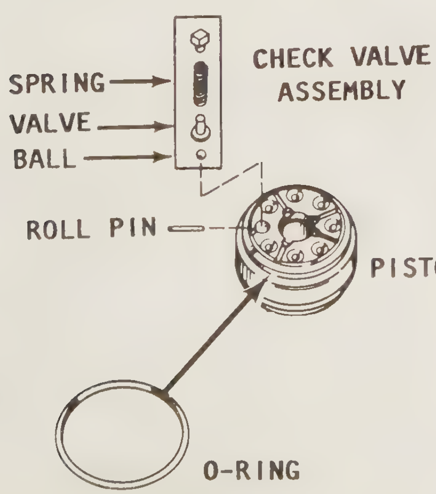
18

of the rod. Remove and discard the **O**-ring from the piston assembly. Clean, but **DO NOT** remove the check valve held in place by the roll pin. If the check valve is defective, the piston assembly **MUST** be replaced

18- Disassemble the end cap by first removing the retaining ring, then the washer. The scraper/seal can now be popped out with a small screwdriver. Remove the **O**-ring.

19- The check valves on the back side of the piston may be removed, if there is evidence the springs do not function properly. Removal is accomplished by first driving the roll pin out using a fine punch or nail and hammer, and then removing the check valve including the spring and ball.

19A- Remove the memory piston from the tilt cylinder on Design II and Design III by first draining any fluid remaining in the cylinder. Place a towel or shop cloth on the bench surface and tap the open end of the cylinder (vertical position), onto the cloth -- as depicted in the accompanying line drawing. The memory piston will fall free. Remove and discard the **O**-ring from the memory piston.



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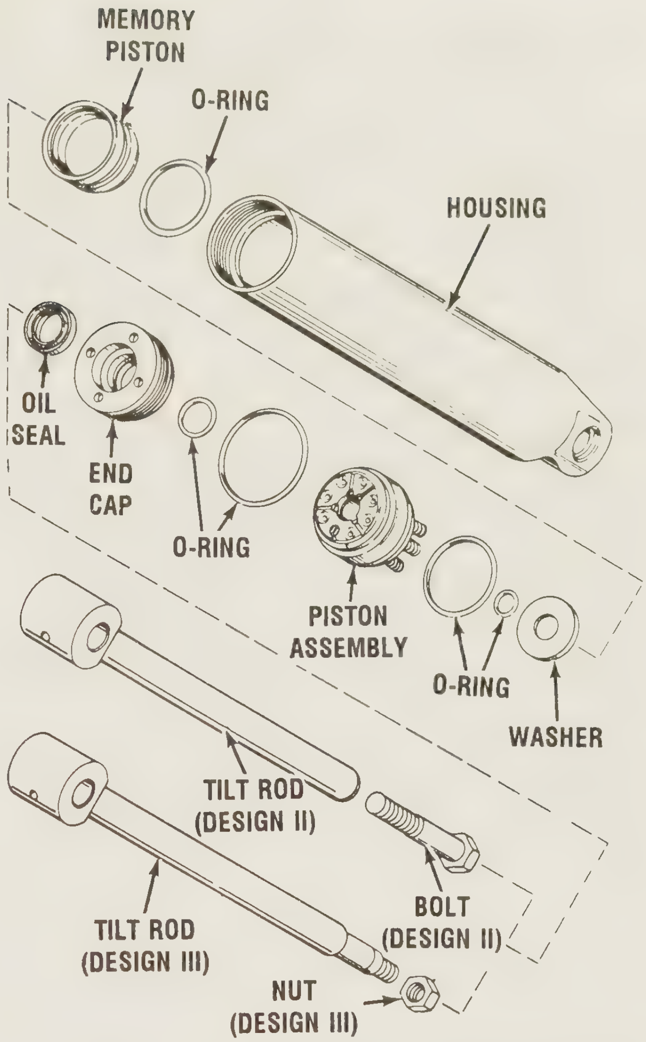
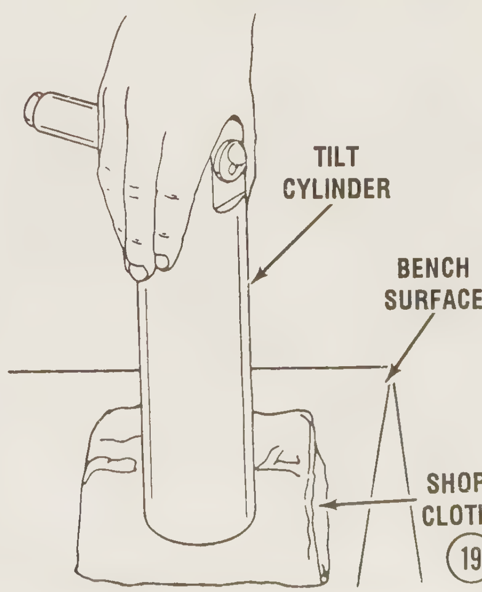


*Exploded drawing of the Design II and Design III tilt piston with major parts identified. O-ring repair kit includes the oil seal. Memory piston for the tilt pistons are different and **MUST** be used with the correct tilt rod/cylinder assembly. Memory piston for Design II tilt piston is flat. Design III is dished to clear nut and thread.*



19 A

ELECTRIC MOTOR SERVICE AND HYDRAULIC PUMP REMOVAL

The electric motor would be removed if troubleshooting leads to the motor as the source of the problem. The pump will be removed with the motor and two will be separated after removal.

The pump **CANNOT** be serviced. Therefore, if troubleshooting indicates the pump has failed, it **MUST** be replaced.

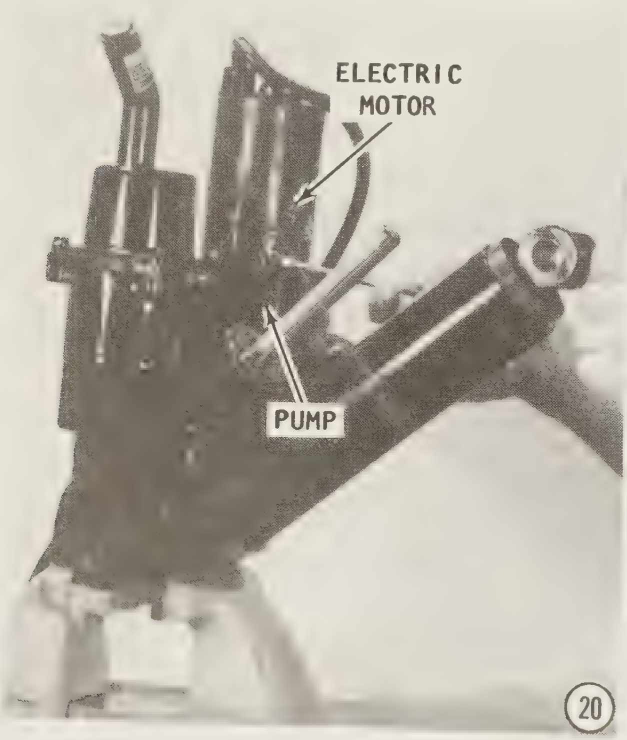
SPECIAL WORDS

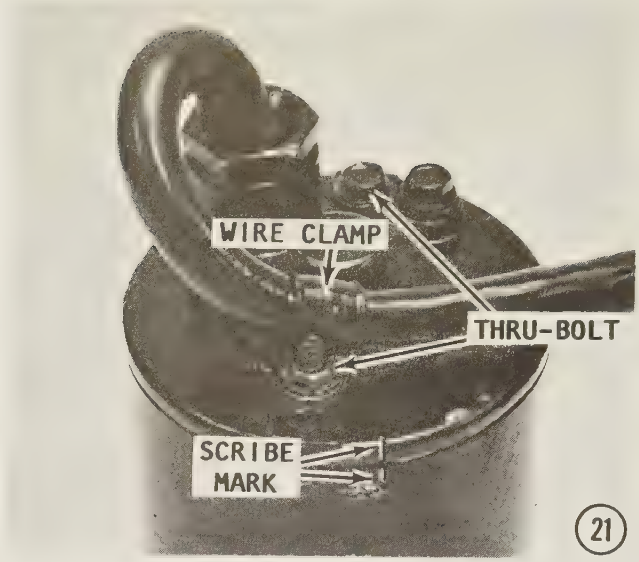
The electric motor and the pump may be removed from the trim/tilt assembly without removing the complete unit from the clamp bracket. To remove the motor and pump without disturbing other parts, perform the PRELIMINARY tasks to move the starboard clamp bracket clear as outlined in Steps 1 thru 7 of this section. After the clamp bracket is clear, proceed with Step 20.

20- Remove the two bolts securing the pump to the trim/tilt assembly. Lift the electric motor, with the pump attached, upward and free of the trim/tilt assembly base.

STOP

Before separating the electric motor from the pump, scribe a mark on the motor end cap and a matching mark on the motor case as an aid to assembling.



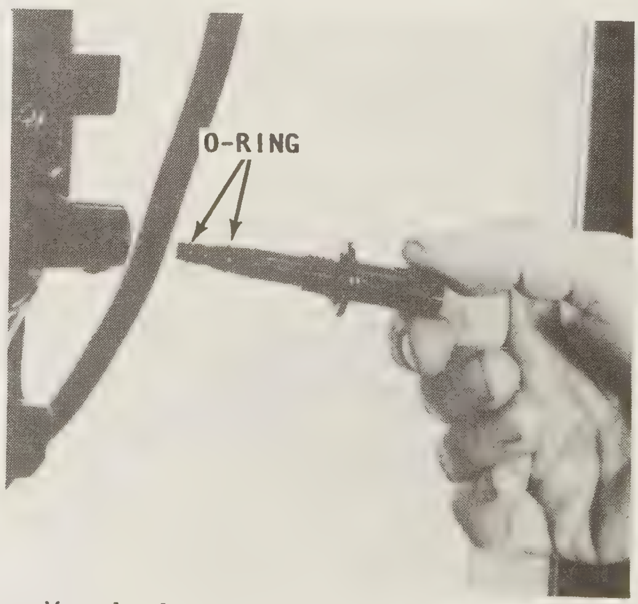


21- Remove the wire clamp from one of the thru-bolts. Remove the two thru-bolts passing through the electric motor into the pump, and then separate the electric motor from the pump. As the electric motor case is being lifted, exercise **CARE** not to drop and damage the armature.

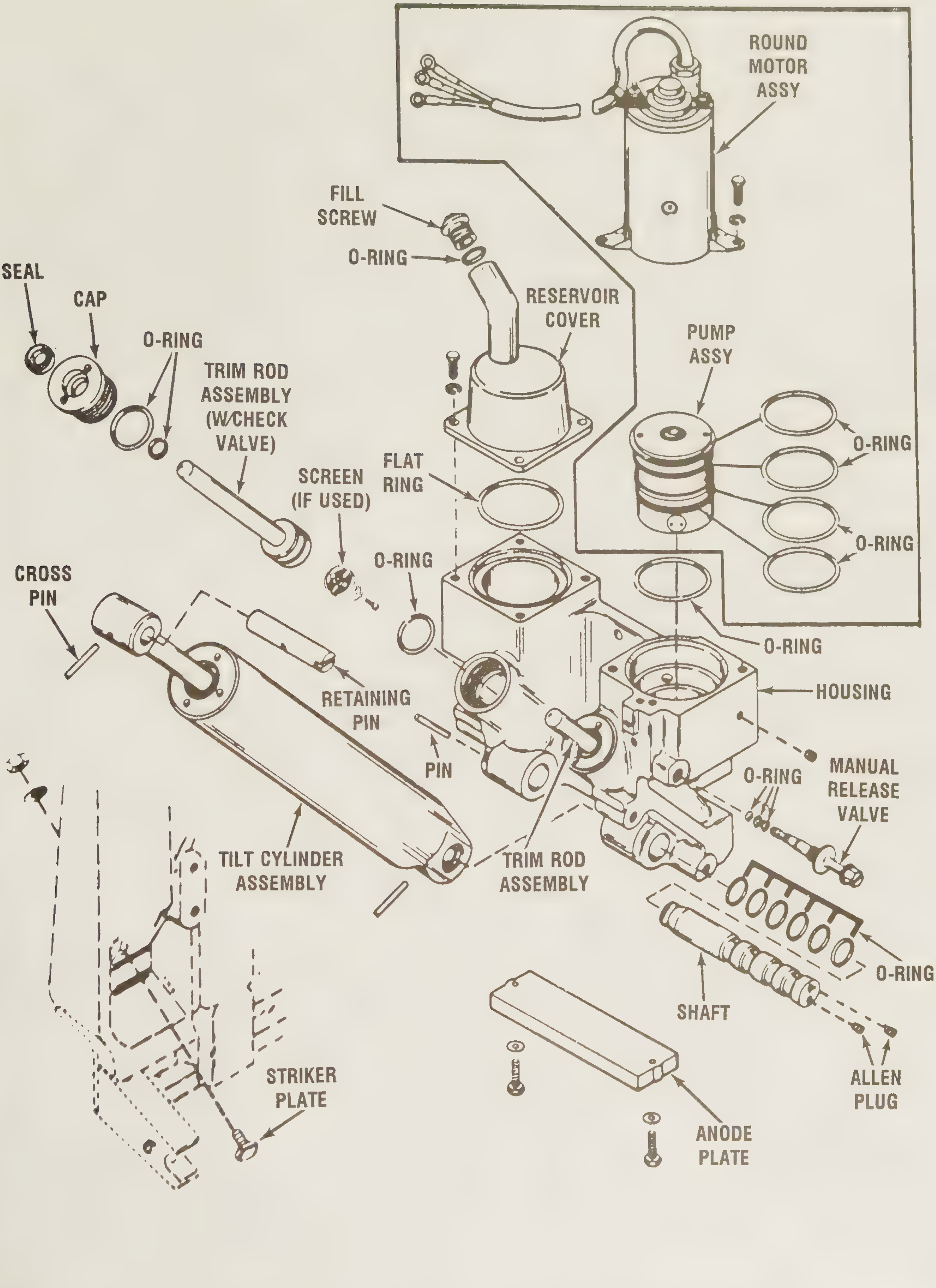
CLEANING AND INSPECTING TRIM/TILT SYSTEM

GENERAL PRACTICE

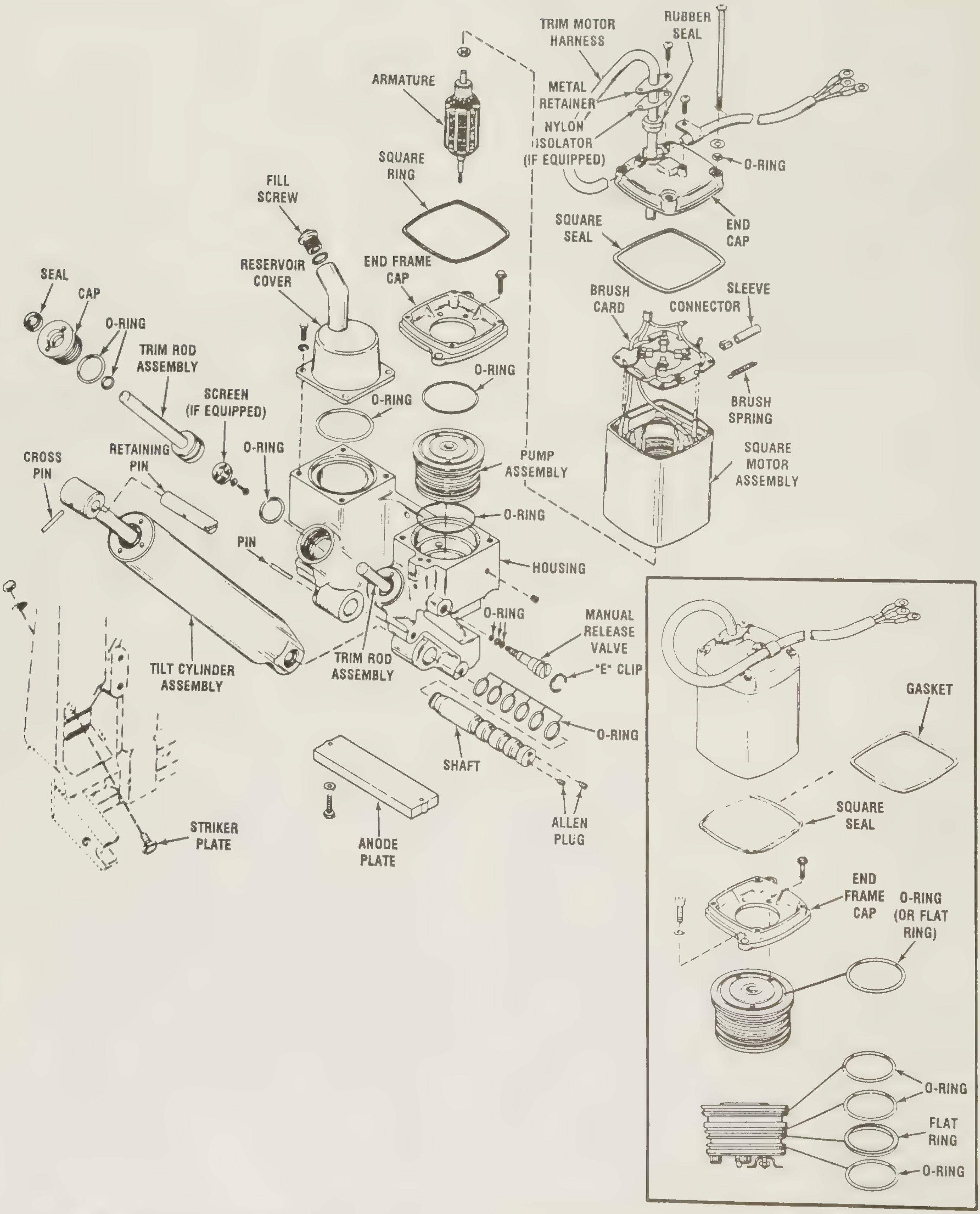
Check all O-rings for any damage. Actually, good shop practice would dictate new O-rings be installed anytime a part is disassembled exposing an O-ring.



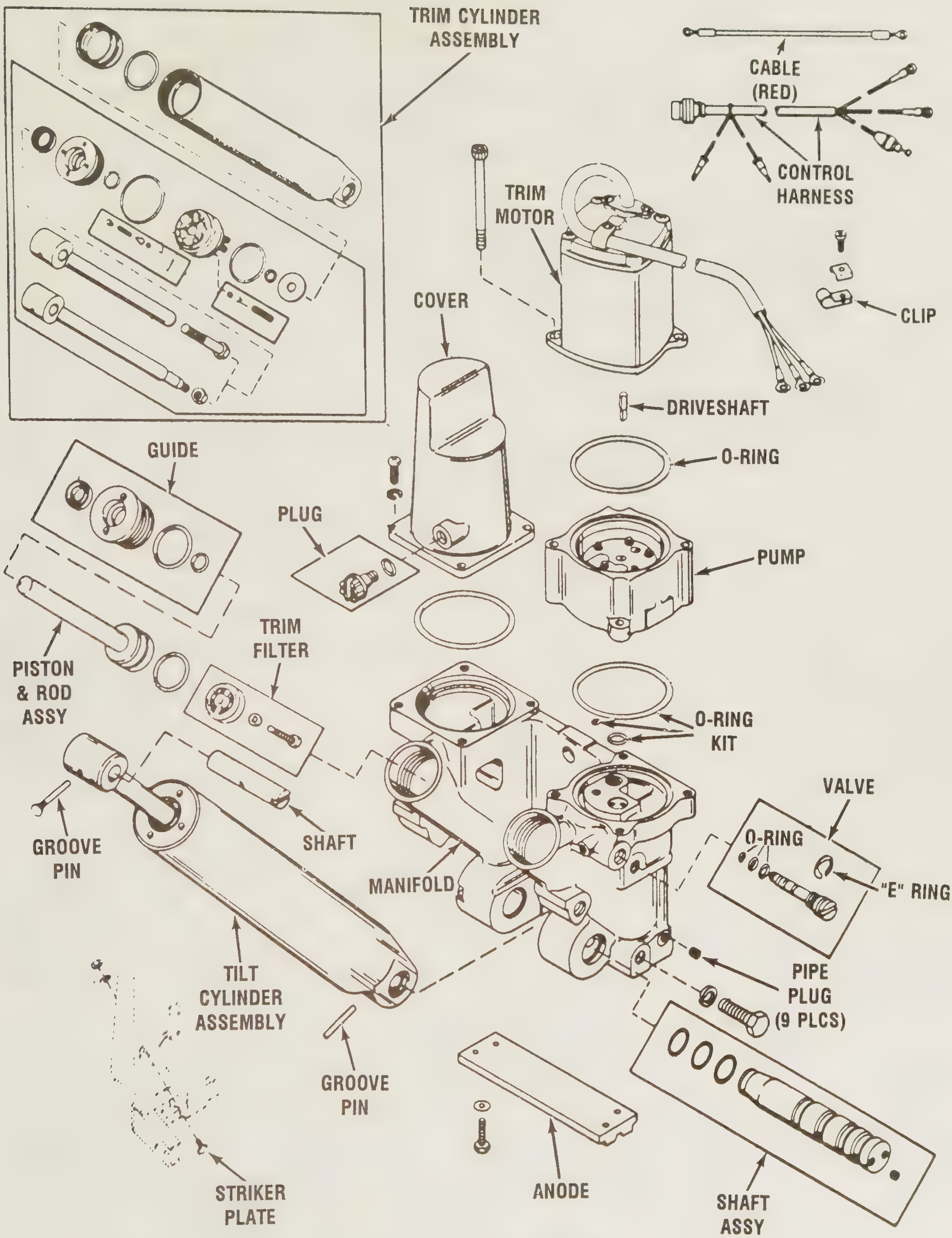
*Manual release valve ready for installation. One style valve has two O-rings and the other has three. The valves are **NOT** interchangeable.*



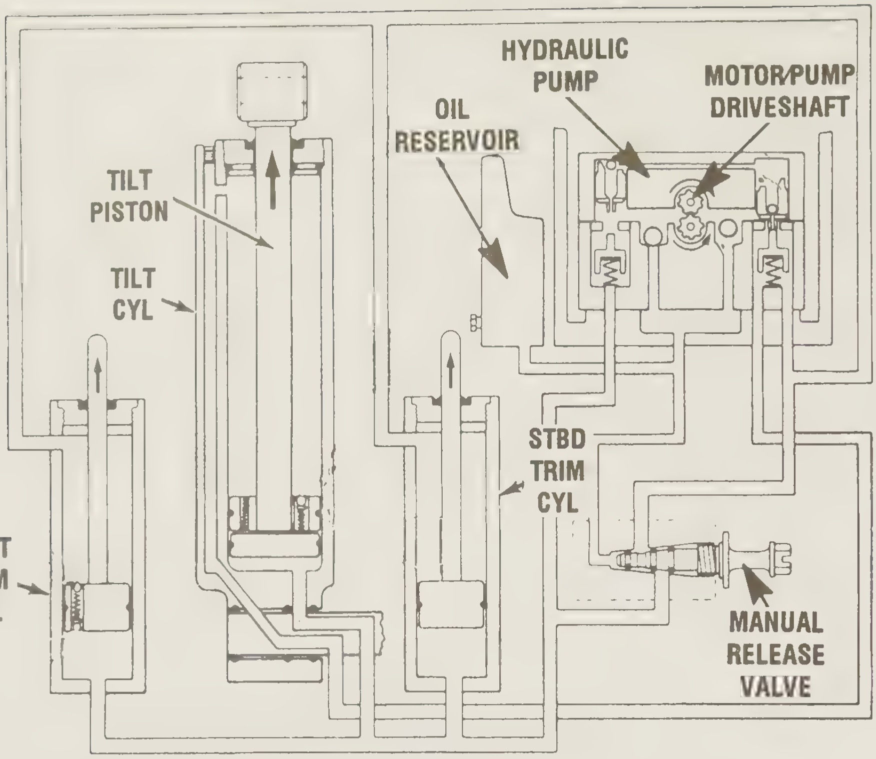
*Exploded drawing of Design 1 -- trim/tilt System "**B**". Major parts are identified.*



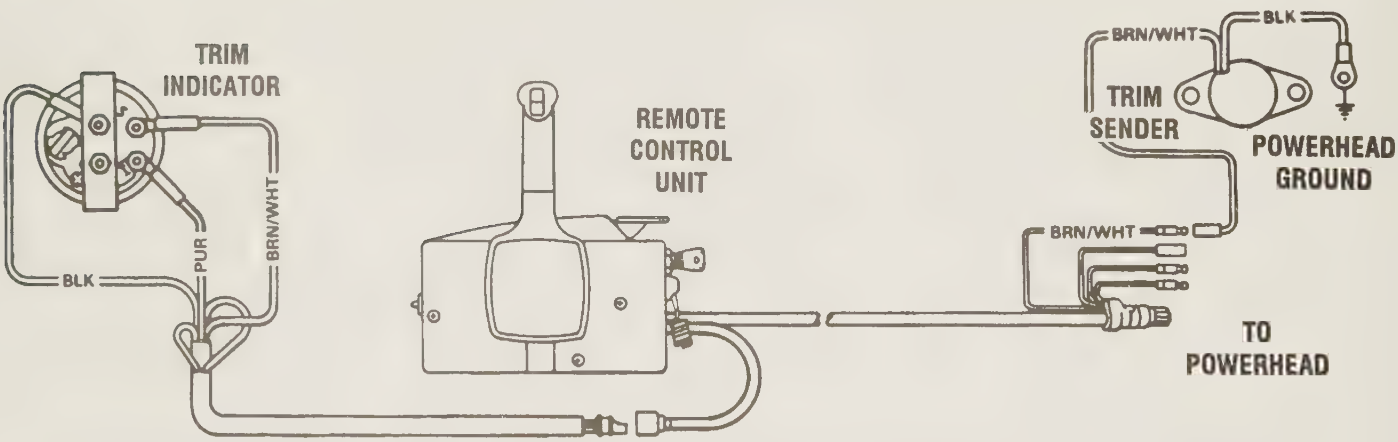
Exploded drawing of Design 2 -- trim/tilt System "B". Major parts are identified.



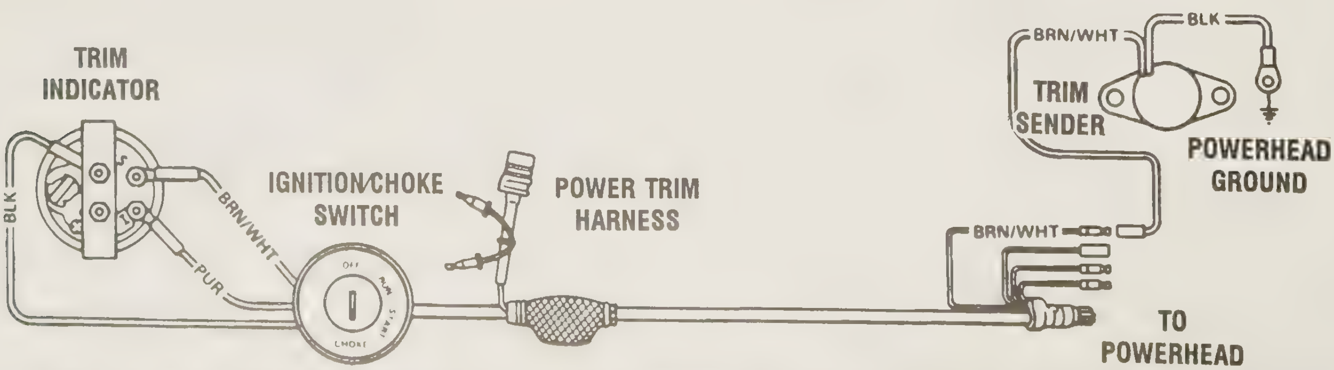
*Exploded drawing of Design 3 -- trim/tilt System "**B**". Major parts have been identified.*



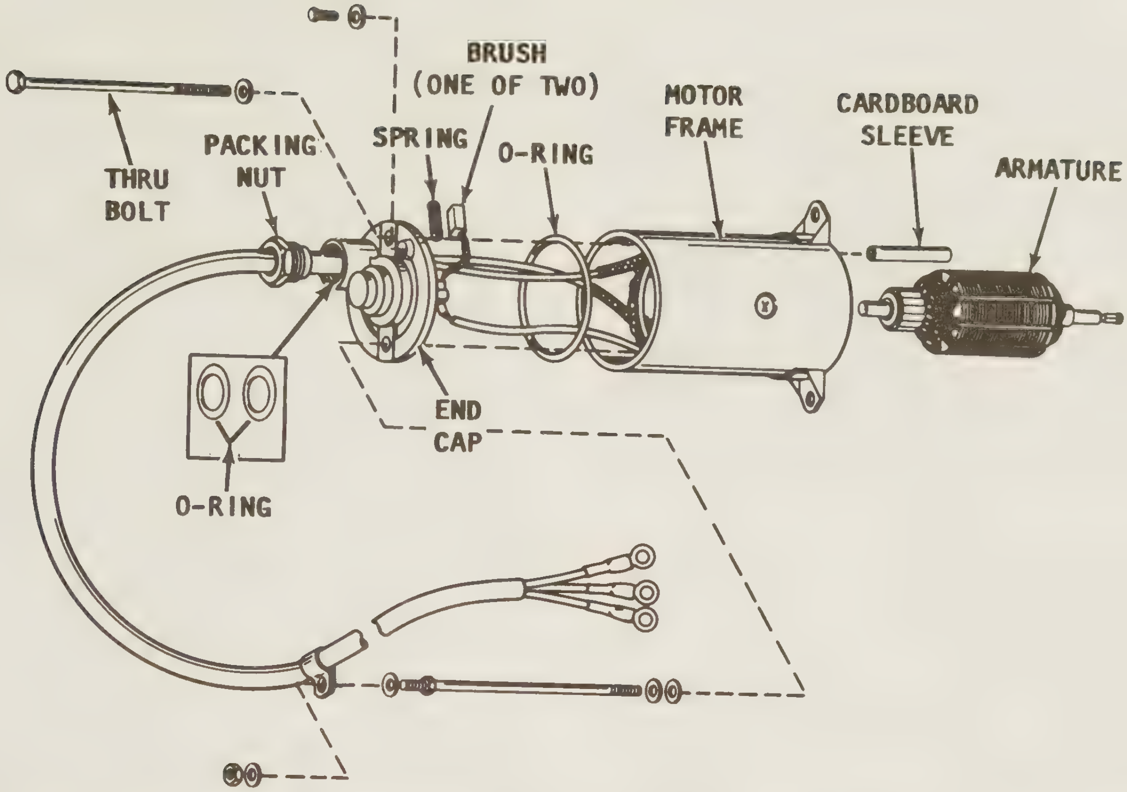
Simple functional hydraulic diagram to depict the trim/tilt 3-cylinder system covered in this section.



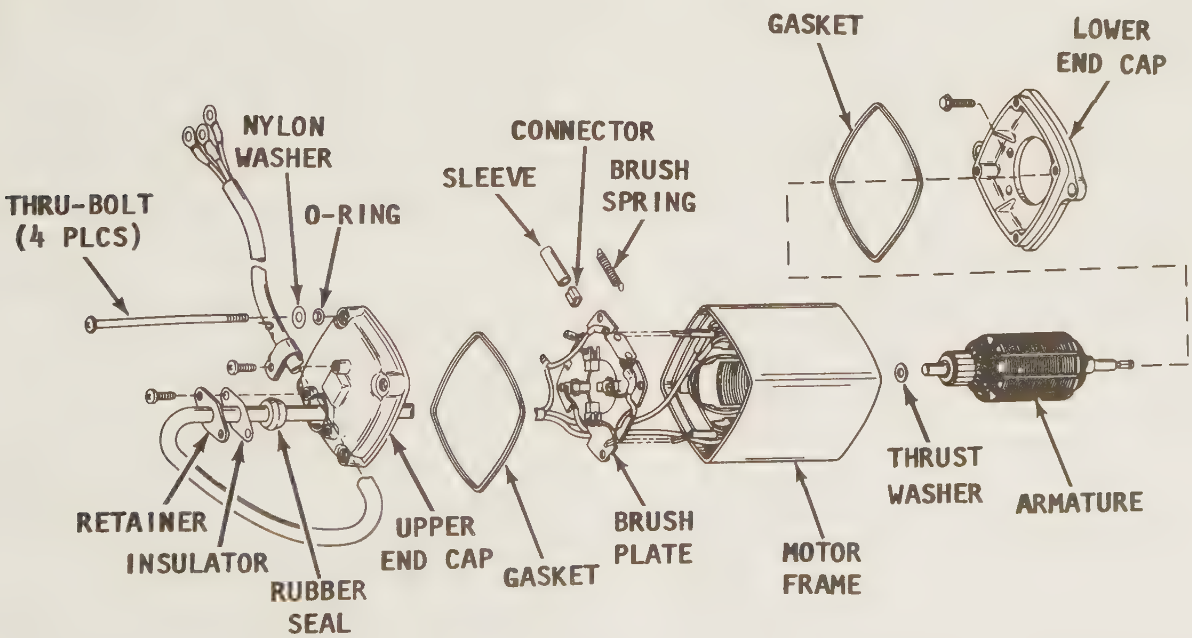
Trim indicator functional wiring diagram for boats equipped with Quicksilver Commander Series side mount remote control.



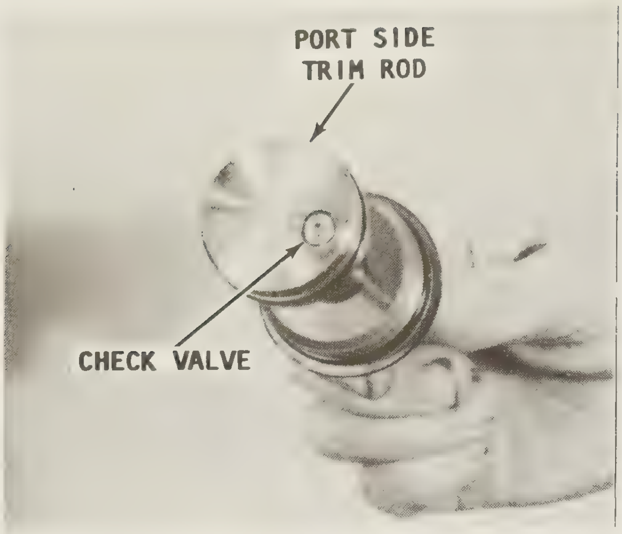
Trim indicator functional wiring diagram for boats equipped with Quicksilver Ignition/Choke and main harness assembly.



*Exploded drawing of a "round" electric motor used with Design I -- System "**B**" Power Trim/Tilt system.*



*Exploded drawing of a "square" electric motor used with Design II and Design III -- System "**B**" Power Trim/Tilt. system.*



*The check valve in the end of the port trim cylinder **MUST** not be removed. The valve is preset at the factory.*

Pump and Motor

The pump **CANNOT** be serviced. Therefore, if troubleshooting indicates the pump has failed, it **MUST** be replaced.

The electric motor is very similar to other electric motors used on the outboard unit. Brush replacement, armature testing, and field tests may be made in the same manner. Therefore, the motor can be checked, tested, and serviced following the procedures outlined in Chapter 7 for other motors.

Check the mating surfaces of the motor and pump to ensure they are clean and undamaged.

A "Pump Seal Kit" is available at the local marine store. This kit includes three **O**-rings and a flat ring for the hydraulic pump.

Manual Release Valve

One style manual release valve has three **O**-rings and the other style has only two. The valves are **NOT** interchangeable. Therefore, be sure to replace the valve with the same style as the one removed.

Trim Cylinder

DO NOT remove the check valve from the port side trim rod. (The starboard rod does not have a check valve.) This check valve has been preset at the factory to operate at a specific pressure. Therefore, removal and installation of the check valve could result in improper operating pressure and possible damage to the system.

If the check valve cannot be cleaned satisfactorily, the trim piston and check valve **MUST** be replaced as a unit. A new piston will have a plastic screen over the top of the check valve. This screen prevents foreign material from entering the check valve. However, if the old piston does not have this plastic screen, then remove the plastic screen from the new replacement piston and install it into the cylinder **WITHOUT** the screen. If the old piston has the screen, then install the new piston with the plastic screen over the check valve.

Inspect the interior of the cylinder for any sign of scoring or roughness. Inspect the seal located in the recess of the end cap. If the seal is damaged or fails to keep the trim piston rod clean, replace the seal. This is accomplished by first prying the old seal from the top of the cap with a screwdriver, and then pushing the new seal into place with the seal lip facing **UP.**

Tilt Cylinder

A "Tilt Cylinder O-ring Kit" is available at modest cost. In addition to the five **O**-rings needed for complete replacement on the tilt cylinder, the kit also includes a new scraper/seal and a washer used next to one of the **O**-rings.

Inspect the balls and the springs underneath the rod end for foreign material.

Inspect the interior of the cylinder for any sign of scoring or roughness.

Examine the check valves and clean them thoroughly of any foreign material.

Clean all parts with solvent, and then blow them dry with compressed air.

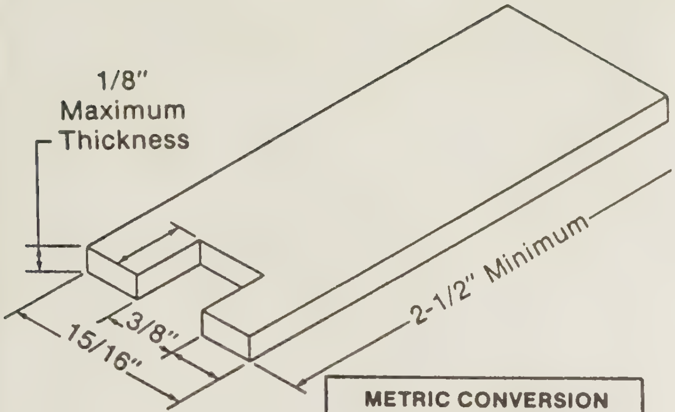
ASSEMBLING/INSTALLATION SYSTEM "B" TRIM/TILT

FIRST THESE WORDS

Hydraulic systems are very sensitive. The work area **MUST** be clean and kept clean. All parts **MUST** be absolutely clean prior to installation. The slightest bit of foreign material could cause the system to malfunction.

All **O**-rings and seals must be coated with automatic transmission fluid just before they are installed.

Check with the exploded diagrams to ensure the correct **O**-ring is being installed



METRIC CONVERSION
1/8" = 3.2mm
3/8" = 9.5mm
15/16" = 23.8mm
2-1/2" = 63.5mm

"Home made" tool to assist in holding the brushes clear when the armature is inserted into the case.

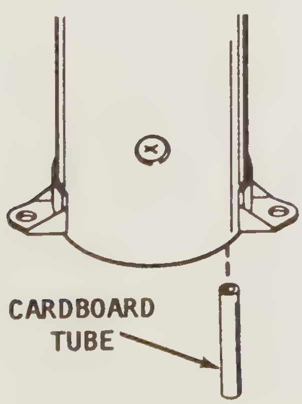
in the proper place. An incorrect O-ring installation could cause the system to malfunction.

PUMP AND MOTOR

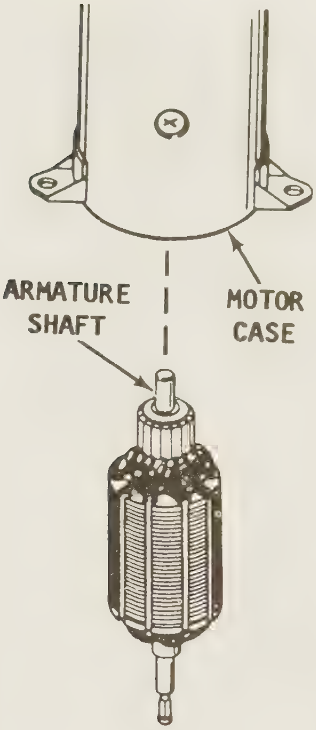
The following procedures pickup the work after a new pump has been obtained, and/or the electric motor has been rebuilt and is ready to be assembled and mated with the hydraulic pump.

The accompanying exploded drawings of the "round" motor, and the "square" motor on Pages 10-37, 10-38, and 10-39 and the small drawings of the two motors on Page 10-44 with the O-ring sizes given, will be an aid to installing the proper ring into the correct groove.

1- Slide the cardboard tube into the case, as shown in the accompanying illustration. Place a **NEW O**-ring into place on the end cap. Set the cap aside, ready for installation.



1



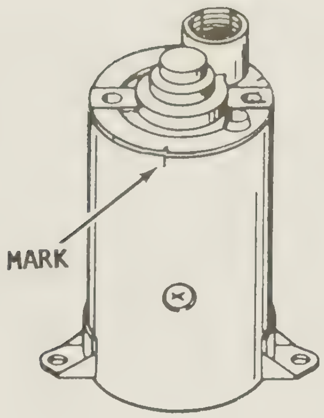
2

SPECIAL WORDS

As an aid to holding the brushes clear when the armature is inserted into the case, a special tool may be made, as indicated in the accompanying illustration at the top of the first column on this page. Because the tool is made of such light weight material -- only 1/8" (3.2mm) maximum thickness -- the short time involved in cutting out the piece will be time well spent in speeding the assembling process and avoiding frustration in inserting the armature into the case.

2- Apply a light coating of SAE 10W motor oil to the upper end of the armature shaft. Place the tool mentioned in the previous paragraph in place to hold the brushes apart when the armature is installed. Push the armature up into the motor case until the upper end of the armature makes contact with the brush holder tool. Exert just a little upward pressure on the armature and at the same time, slide the brush holder out. The armature will move just a little further into the case and the brushes will bear against the armature in a proper manner.

3- Place the end cap onto the case with the mark on the cap aligned with the mark on the case. (These are the marks made just prior to disassembly, as instructed in Step 20.)



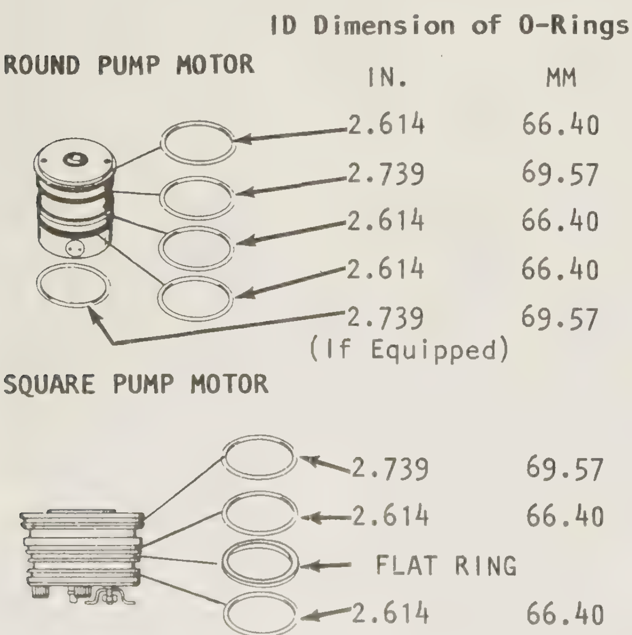
3

4- Install **NEW** O-rings onto the pump. If the square motor pump is used, install the flat ring into the groove, as shown in the accompanying exploded drawing. Install a **NEW** seal into the recess of the upper end of the pump surface. The armature shaft passes through this seal. Coat the O-rings and the seal with Automatic Transmission Fluid.

5- Grasp the motor case with the thumb and forefinger holding the end cap in place, and position it over the pump. Push down on the motor case with the lower end of the armature passing through the pump seal. The chamfered part of the pump **MUST** be on the same side as the bolt hole opposite the electrical fitting, as shown. Hold the electric motor and end cap with one hand and with the other hand rotate the pump ever so slightly until the hex end of the armature shaft indexes with the recess in the pump. When this occurs, the end surface of the motor case will be firm against the surface of the pump.

6- Slide the sealing washer onto the thru-bolt with the head. The rubber surface of the washer **MUST** face down to bear against the surface of the end cap. Start to thread the bolt into the pump, but **DO NOT** tighten it at this time. Slide a regular washer on the other thru-bolt, and then the sealing washer with the rubber surface facing **DOWN** to bear against the surface of the end cap. Start to thread the second bolt into the pump. A slight shifting of the motor case or the pump may be necessary. Tighten thru-bolts securely.

7- Secure the electrical lead to the thru-bolt without the head, using first a washer, then the wire clamp, another washer, and finally the nut. Tighten the nut securely. Apply a coating of Quicksilver Liquid Neoprene around the thru-bolts, around the electrical connection, and at the seam between the electric motor and the pump, as a waterproof measure.



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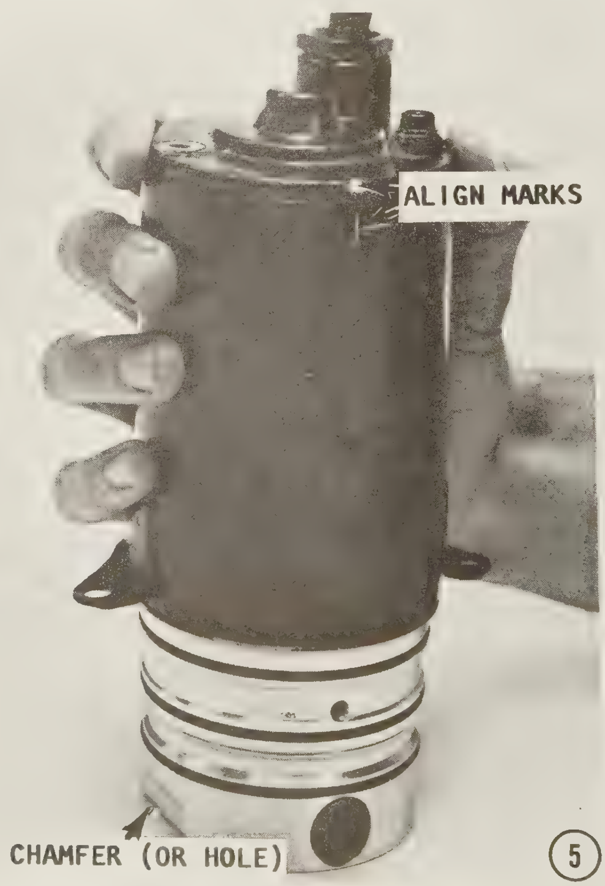

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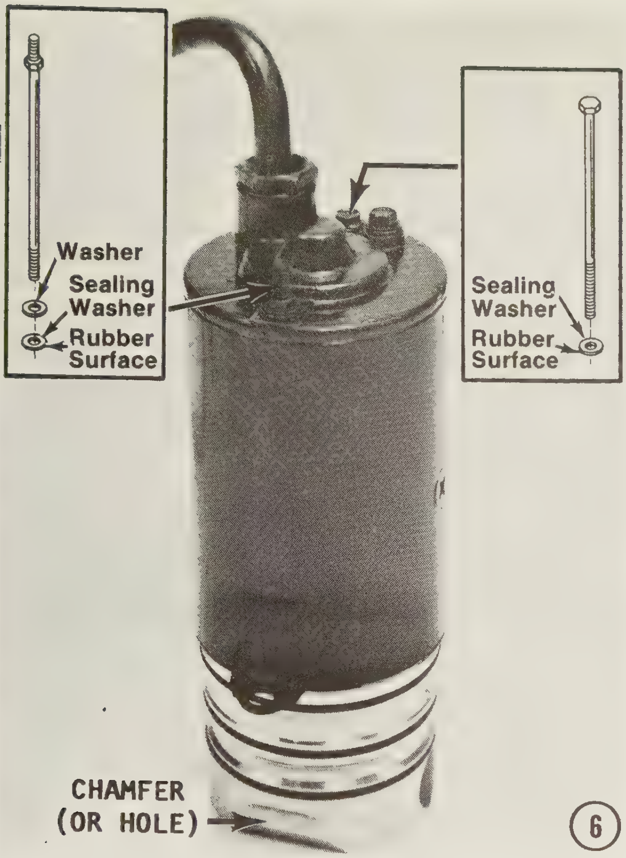
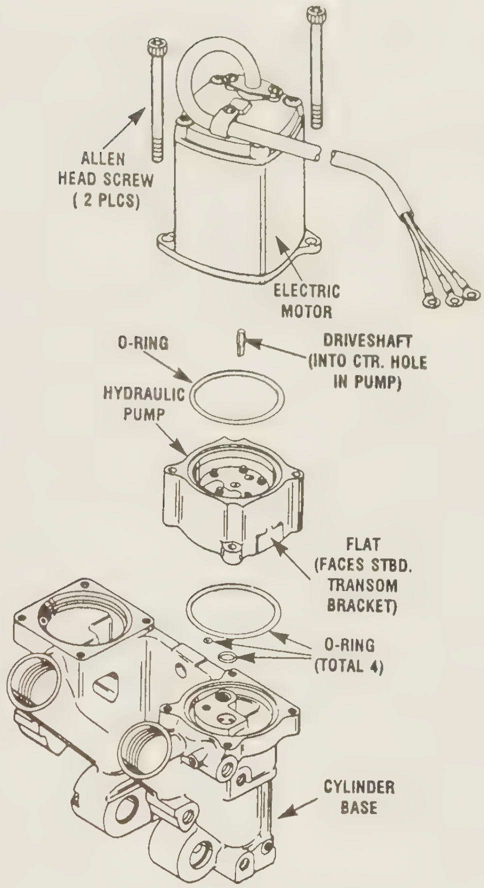


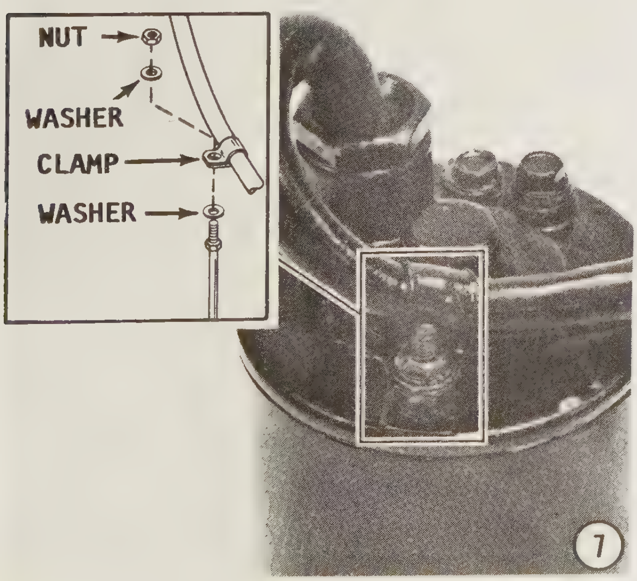


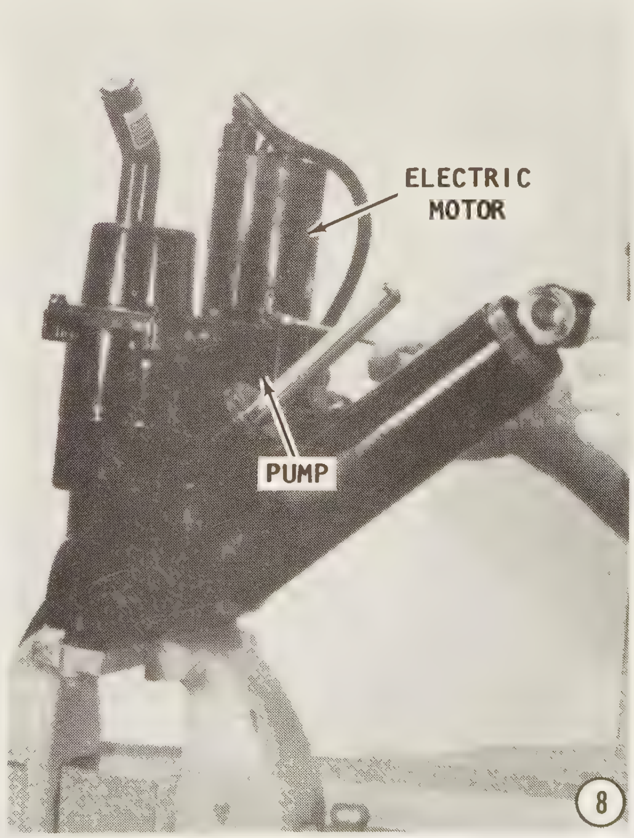
Exploded drawing of the Design III motor and pump, with major parts identified.

SPECIAL WORDS

If the pump and motor were removed after the trim/tilt system was removed, continue with the assembling work, and then install the system according to the procedures outlined in Steps 25 thru 30.

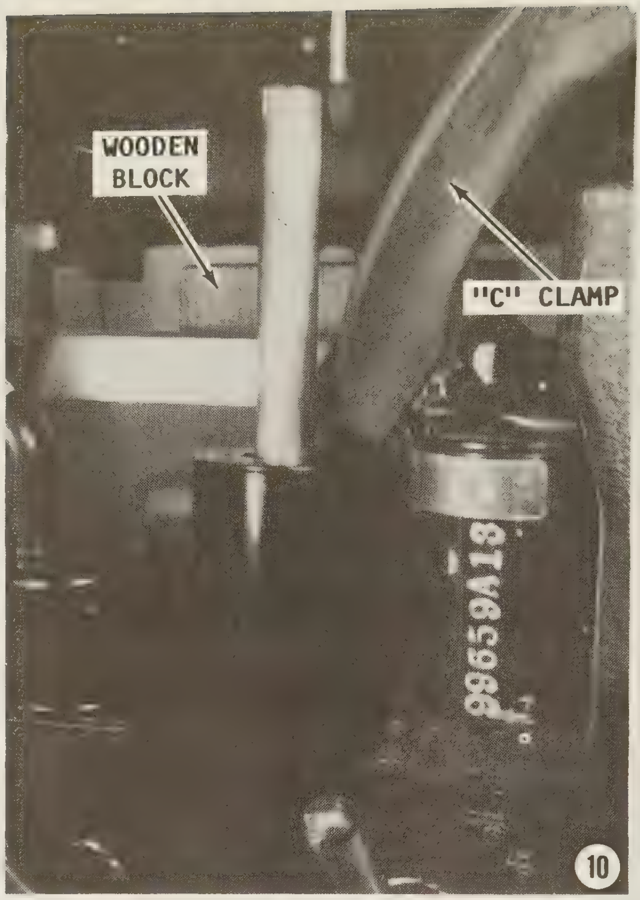
If the pump and motor were removed with the trim/tilt system remaining in place between the clamp brackets, perform Steps 8 thru 11.

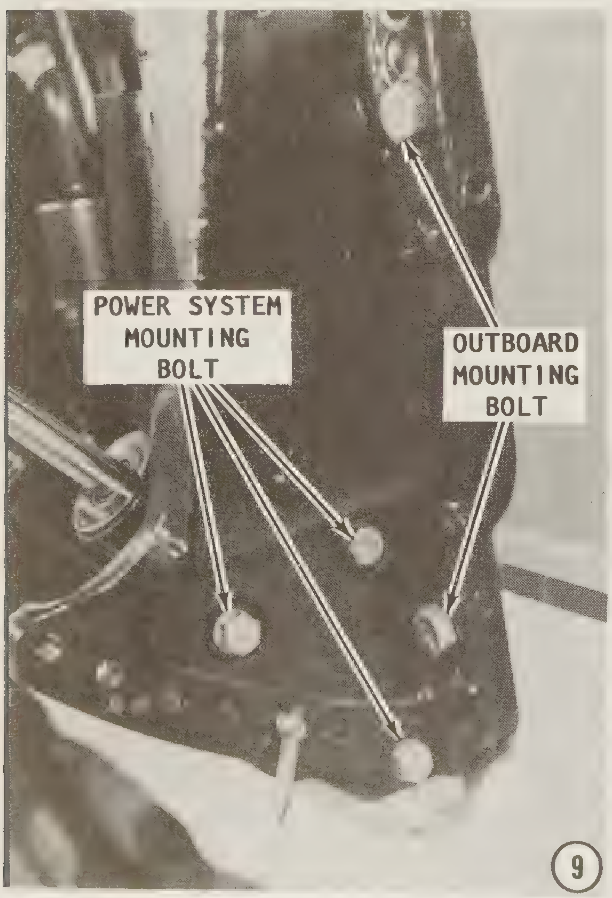


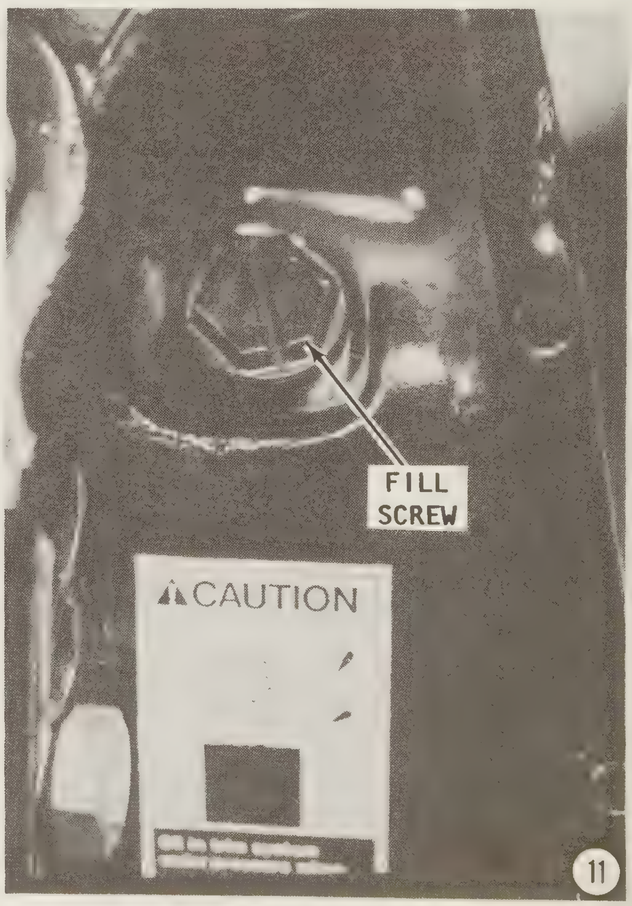


8- Feed the electrical wire up through the outboard clamp bracket, if the motor and pump were removed with the trim/tilt assembly remaining on the clamp brackets. Move the assembled pump and motor into position on the trim/tilt assembly. Carefully insert the pump into the power trim assembly housing, with the chamfer (or hole) on the lower end of the pump facing **TOWARD** the tilt cylinder. Apply a light coating of Quicksilver Perfect Seal (or equivalent) to the threads of the attaching bolts. Slide a lockwasher onto each bolt. Secure the pump on the housing with the attaching hardware. Tighten the bolts securely. Apply a coating of Quicksilver Liquid Neoprene on the seam between the pump and the housing as a waterproof measure.

9- If the trim/tilt assembly was not removed from the brackets, carefully move the starboard transom bracket into place with the manual release valve passing through the opening in the bracket. Apply a light coating of Loctite Grade "A" on the threads of five bolts. Secure the bracket in place with the two outboard mounting bolts, and the three bolts through bracket into the







power trim assembly. Tighten the bolts to a torque value of 30 ft lbs. (40.7 Nm).

10- Remove the large C-clamp and block of wood.

11- Remove the fill screw from the port side of the transom bracket or rear of the reservoir. Replenish the reservoir with Quicksilver® Power Trim and Steering Fluid. If the Quicksilver product is not available, use Automatic Transmission Fluid (ATF) Type F, FA or Dexron II.

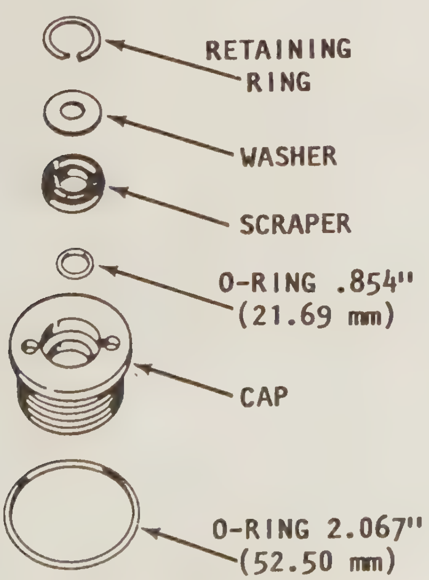
CRITICAL FLUID WORDS

The manufacturer recommends the use of Quicksilver® Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) Type F, FA, or Dexron II. Transmission fluid may be used due to the stable viscosity over a large temperature range. The superior lubricating qualities and anti-corrosion additives makes the ATF fluid compatible with the trim/tilt system. Motor oils should **NOT** be used because these products -- over a long period of time -- will form varnish and gummy deposits on the interior surfaces and valves. These deposits will cause valves to stick and O-rings to fail.

Fill the reservoir until the fluid is visible through the opening. Bleed the system of air, as outlined earlier in this Section.

TILT CYLINDER

12- Assemble the end cap by first working a **NEW** O-ring over the outside of the cap and up under the lip. Next, install a



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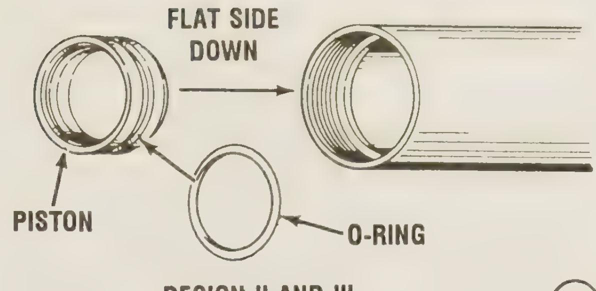
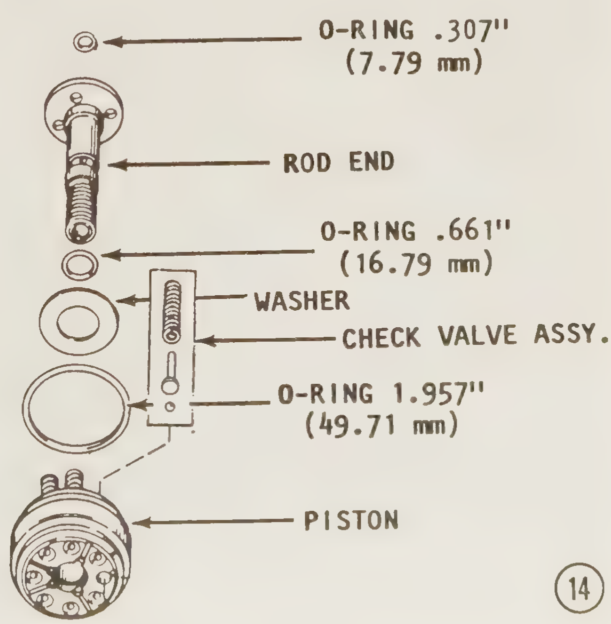


13

NEW O-ring into the recess of the upper side. Insert the scraper/seal into the recess, followed by the washer. Secure them in place with the retaining ring. Clamp the upper end of the rod in a vise equipped with soft jaws. Tighten the vise **JUST** good and snug to prevent damage to the rod. Coat the rod with automatic transmission fluid, and then slide the end cap onto the rod.

13- If the memory piston cup was removed from the cylinder, install the large O-ring over the outside of the piston cup. On Design I pistons install an additional small O-ring in the center. Coat the cylinder walls and the memory piston with transmission fluid. Insert the memory piston into the cylinder with the flat surface going in first.

14- On Design I rod end pistons **ONLY** -- if the check valve assembly held by the roll pin was removed, install the parts in the exact sequence as shown in the accompanying illustration. Secure the check valve in place by driving in the roll pin. If the same check valve was removed from the Design II or III piston - the entire piston assembly **MUST** be replaced.



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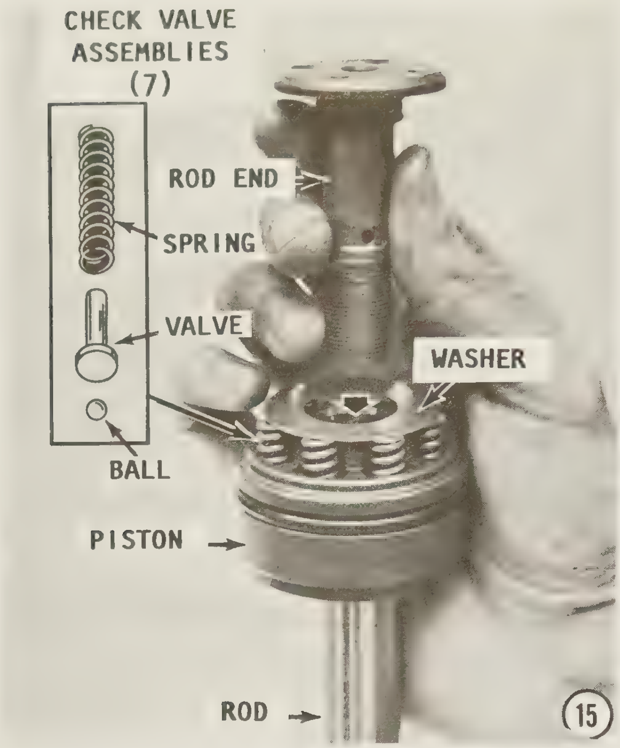
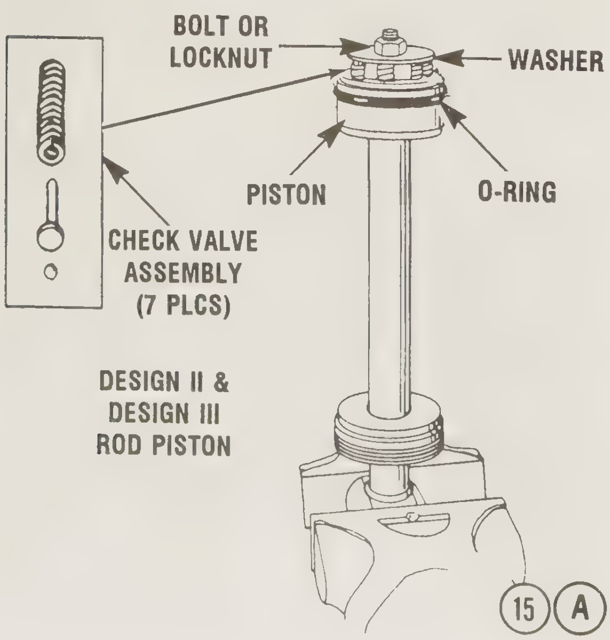
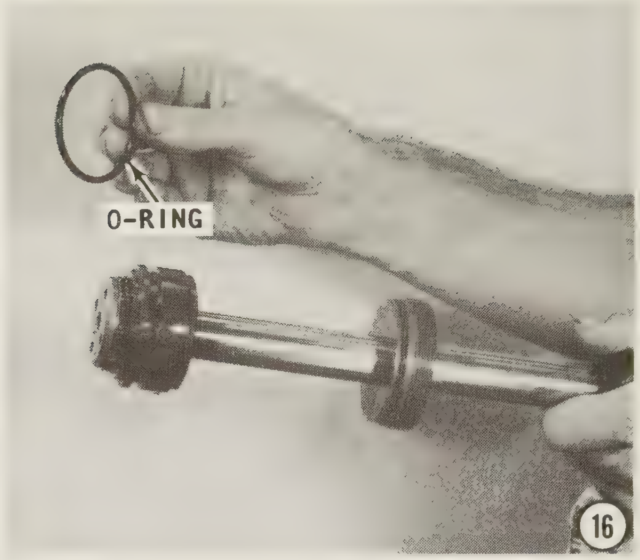


15- Position the piston onto the end of the rod. Assemble the seven check valves in place on the end of the piston with each ball going into the recess first, followed by the valve, and then the spring. After they are all in position, **CAREFULLY** lay the washer on top of the springs. Now, slowly slide the rod end, with **NEW O**-rings in place, down through the center of the washer without disturbing the valve assemblies. Thread the rod end into the end of the rod. Tighten the rod end securely with the spanner wrench.

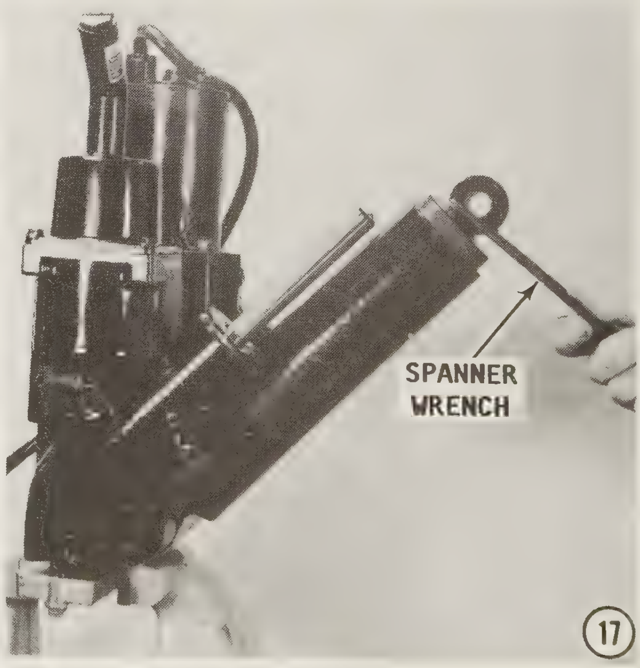




15A- Place a **NEW O**-ring around the rod end piston. Position the piston onto the end of the rod. Assemble the seven check valves in place on the end of the piston with each ball going into the recess first, followed by the valve, and then the spring. After all components are in position, **CAREFULLY** lay the washer on top of the springs. Place the nut (Design III) or guide the bolt (Design II) onto the end of the rod. Tighten the nut or bolt securely.

16- After **NEW O**-rings have been installed and all parts coated with Automatic Transmission Fluid, slide the piston and rod assembly into the cylinder.

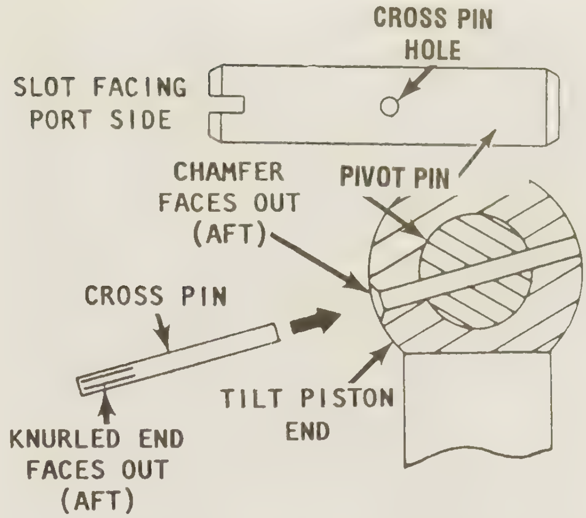
17- Secure the piston and rod assembly in the cylinder by tightening the end cap with a spanner wrench.



SPECIAL WORDS

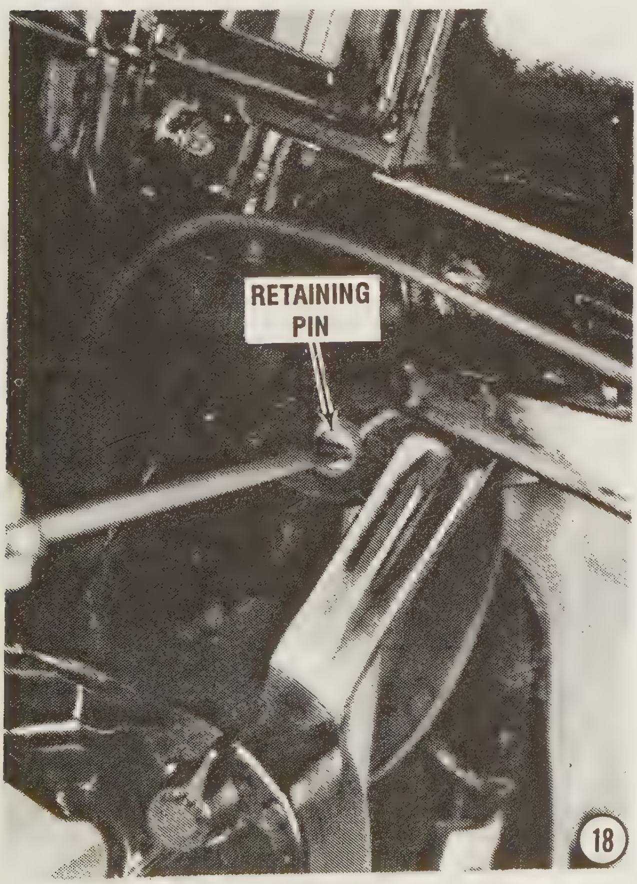
If the tilt cylinder was serviced without removing the trim/tilt system from the clamp brackets, perform Steps 18 and 19.

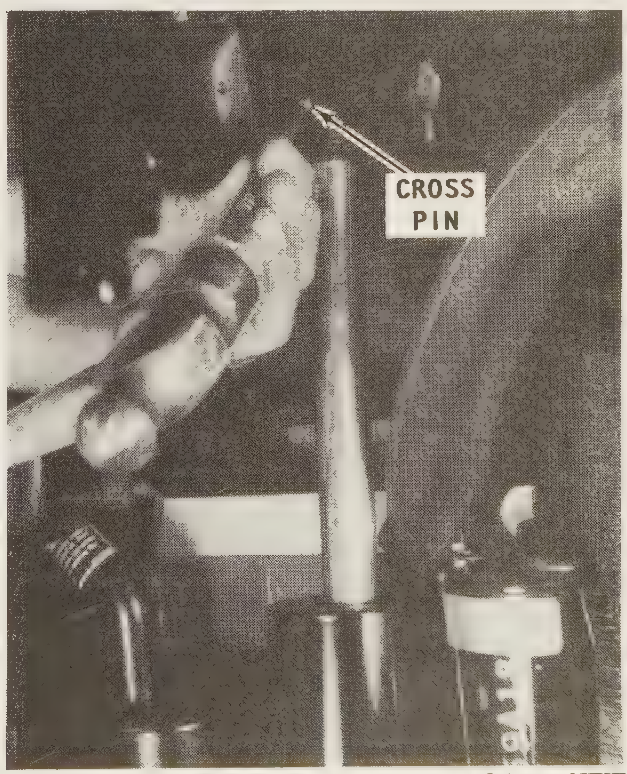
If the tilt cylinder was serviced after the tilt/trim system was removed, continue with the assembling work, and then install the system according to the procedures outlined in Steps 25 thru 30.



The pivot pin can be rotated with a large screwdriver until the hole in the pin is aligned with the hole in the end of the tilt piston. The chamfered hole in the end of the piston must face ***OUTWARD****. If it does not, remove the pivot pin and rotate the piston in the cylinder 1/2 turn.*

18- Connect the electrical leads to a 12-volt battery. Depress the **UP** button to extend the piston to the full up position. Start the pivot pin into the port transom with the non-slotted end going in first. Now, observe how the hole for the cross pin is aligned with the slot in the end of the pivot pin. Also note how the cross pin hole on one side of the pivot pin is chamfered and the other is not. Align the slot approximately with the hole in the end of the tilt piston, and then push the pivot pin through the port bracket, then the end of the tilt piston, and finally through the starboard bracket. Once the pivot pin is installed, rotate the pin very **SLOWLY** with a screwdriver until the hole in the pivot pin is aligned with the hole in the end of the tilt piston. Once the hole is close to alignment, a small punch may be used through the hole in the piston end to rotate the pivot pin. After the hole is aligned, drive the cross pin into place with the smooth end of the cross pin going in first. Continue to drive the pin with a hammer and punch until the pin is flush with the surface of the piston end.

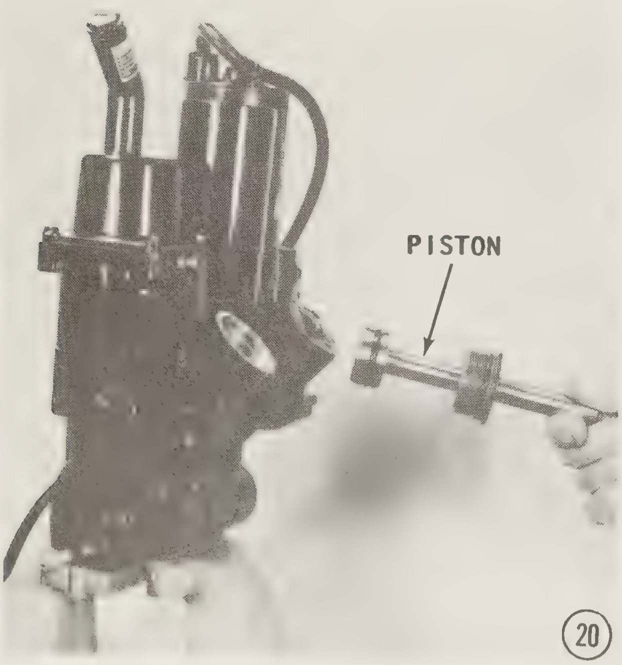




Using a small punch and hammer to drive a ***NEW*** *cross pin into place,* ***AFTER*** *the hole has been aligned as indicated in the line drawing at the top of this column.*

19

19- Remove the fill screw from the port side of the transom bracket or rear of the reservoir. Replenish the reservoir with Quicksilver® Power Trim and Steering Fluid. If the Quicksilver product is not available, use Automatic Transmission Fluid (ATF) Type F, FA or Dexron II. Fill the reservoir until the fluid is visible through the opening. Bleed the system of air, as outlined earlier in this section.



20

TRIM CYLINDERS

20- After **NEW** O-rings have been installed, coat the surface of the piston, the O-rings, and the seal lip with Automatic Transmission Fluid. Carefully slide the piston into the cylinder.

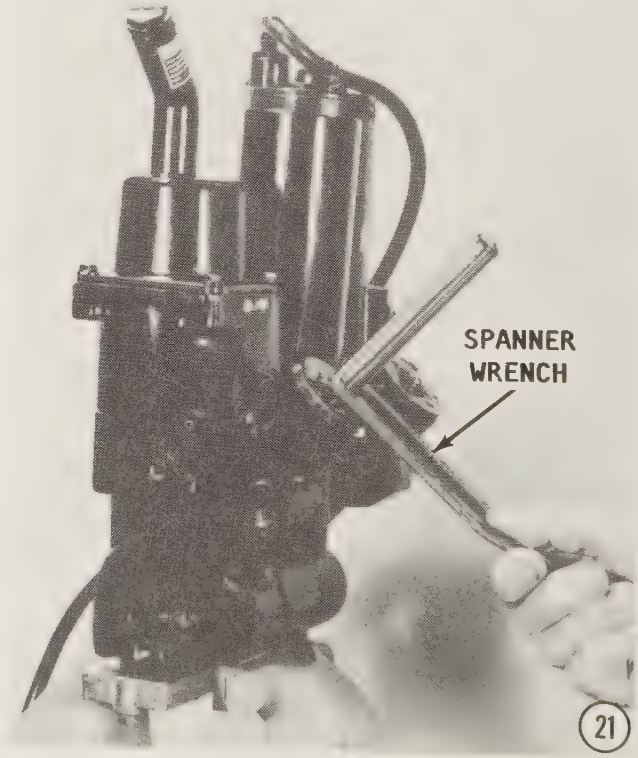
21- Thread the end cap onto the end of the cylinder and then tighten the cap securely with a spanner wrench. Lubricate the piston rod with Anti-Corrosion Grease.

If the tilt/trim system was not removed from the clamp brackets, remove the support safety tool by removing the cotter pins and pulling it free. Release the tilt lock lever, and then operate the system through several full cycles from full up to full down. Check the fluid level through the fill screw opening and add fluid as required.

If the trim/tilt system was removed from the brackets continue with the assembly work and then install the assembly according to Steps 25 thru 30.

FLUID RESERVOIR COVER

22- After a **NEW** O-ring has been installed, position the cap in place on the reservoir. If the trim/tilt system was not removed from the clamp brackets, position the upper end of the fill tube in the clamp



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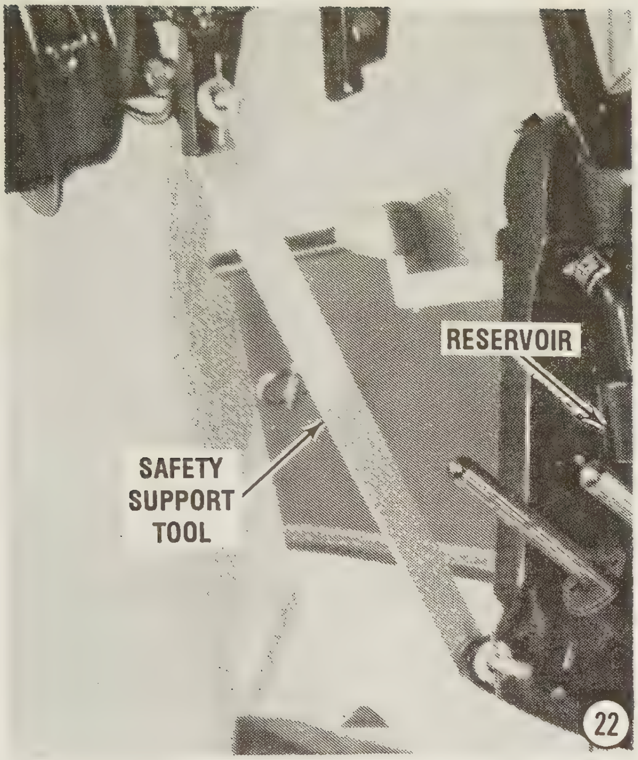
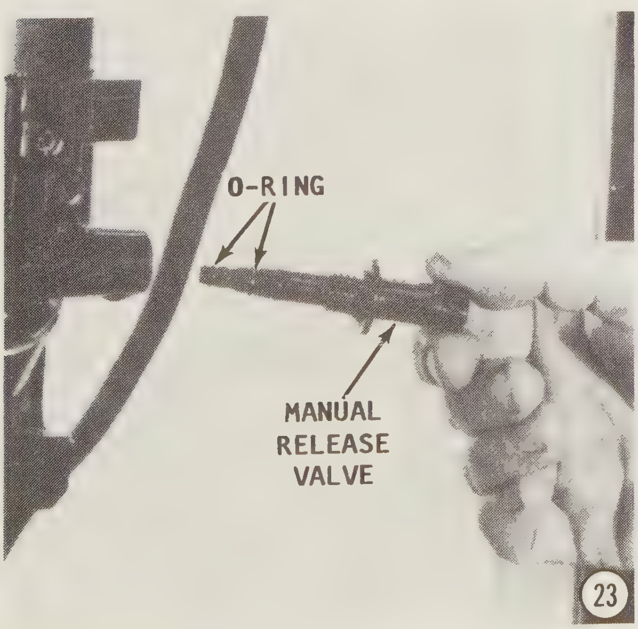


bracket hole, and then rotate the cover into position. Secure the cover with the attaching hardware. Use the proper size socket with an extension to install the bolts on the back side. Fill the system with fluid. Install and tighten the fill screw securely.

Remove the support safety tool by removing the cotter pins and pulling it free. Release the tilt lock lever, and then operate the system through several full cycles from full up to full down. Check the fluid level through the fill screw opening and add fluid as required.



Bleed the system of air, as outlined earlier in this section.

If the trim/tilt system was removed from the brackets, continue with the assembly work and then install the unit as directed later in this section.

MANUAL RELEASE VALVE INSTALLATION

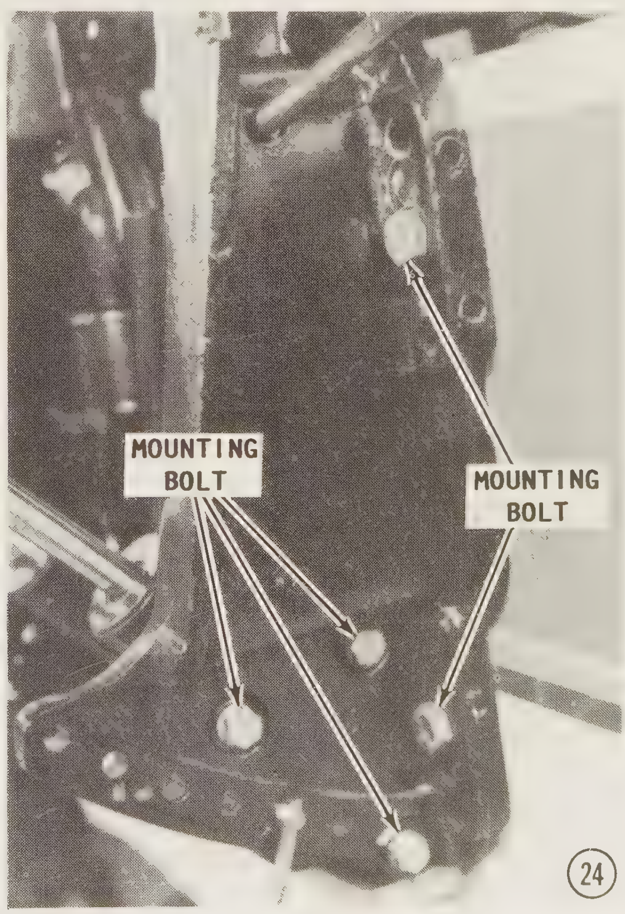
23- Slide new O-rings into place on the manual release valve.

SPECIAL WORDS

One style manual release valve has three O-rings and the other style has only two. Because the valves are **NOT** interchangeable, be sure to replace the valve with the same style as the one removed.

Carefully thread the valve into the pump housing shoulder. Tighten the valve securely.

24- If the valve was removed with the trim/tilt system remaining in the clamp brackets, carefully move the starboard transom bracket into place with the manual release valve passing through the opening in the bracket. Apply a light coating of Loc-



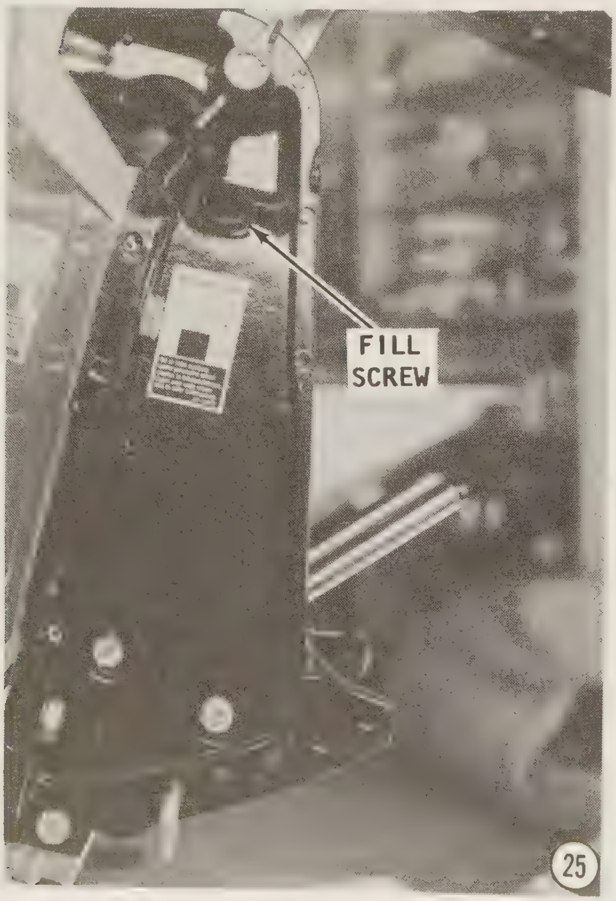
tite Grade "A" on the threads of the five bolts. Secure the bracket in place with the two outboard mounting bolts, and the three bolts through the bracket into the power trim assembly. Tighten the bolts to a torque value of 30 ft lbs (40.7 Nm).

If the manual release valve was removed after the trim/tilt assembly was removed from the clamp brackets, continue with the assembly work. Install the assembly according to Steps 25 thru 30.

INSTALLATION
TRIM/TILT SYSTEM "B"

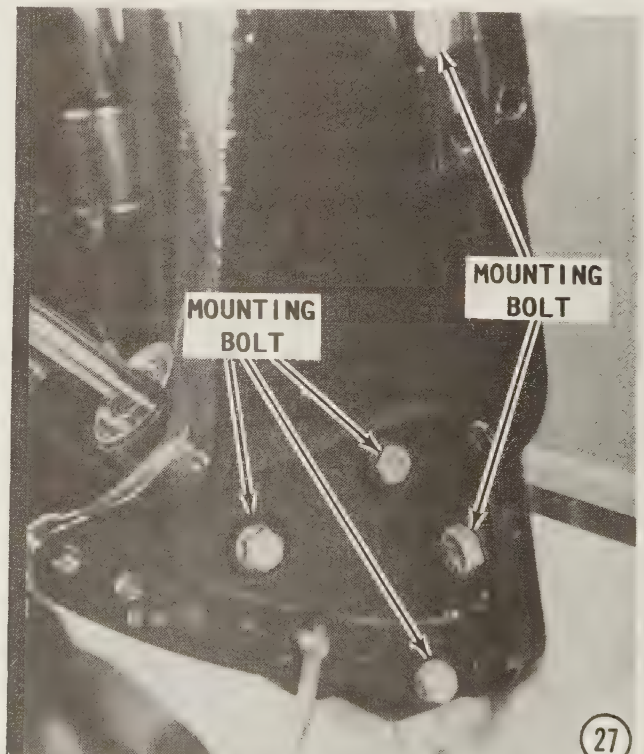
25- Apply a coating of Loctite Grade "A" to the threads of all mounting bolts. Lift the assembly into position between the clamp brackets, with the fill tube indexed in the port clamp bracket hole. Install the three bolts securing the system to the port side bracket. **DO NOT** tighten the bolts at this time.

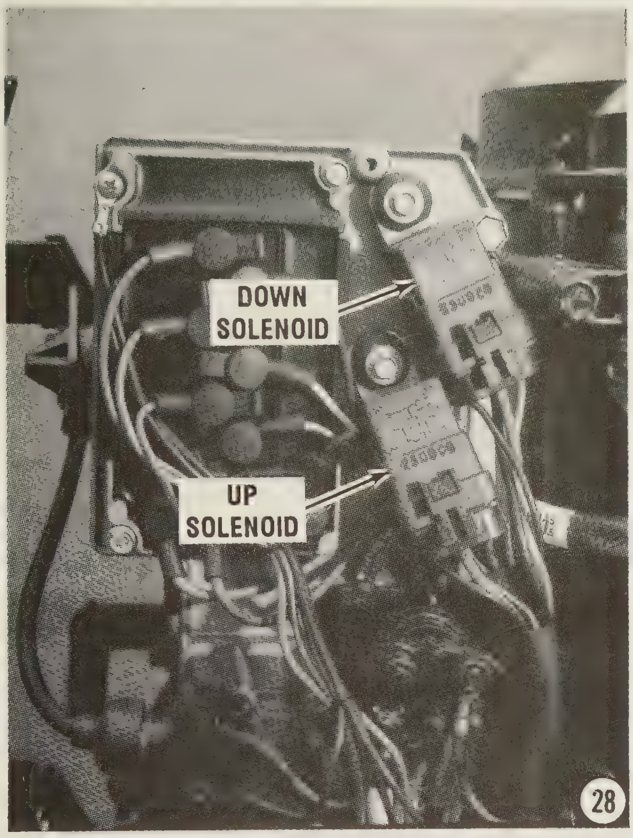
26- Route the wiring through the starboard side clamp bracket. Install the wavy washer onto the tilt tube. Thread the tilt tube nut onto the tube. Tighten the nut securely. Install and tighten the steering



cable retaining nut onto the end of the tilt tube.

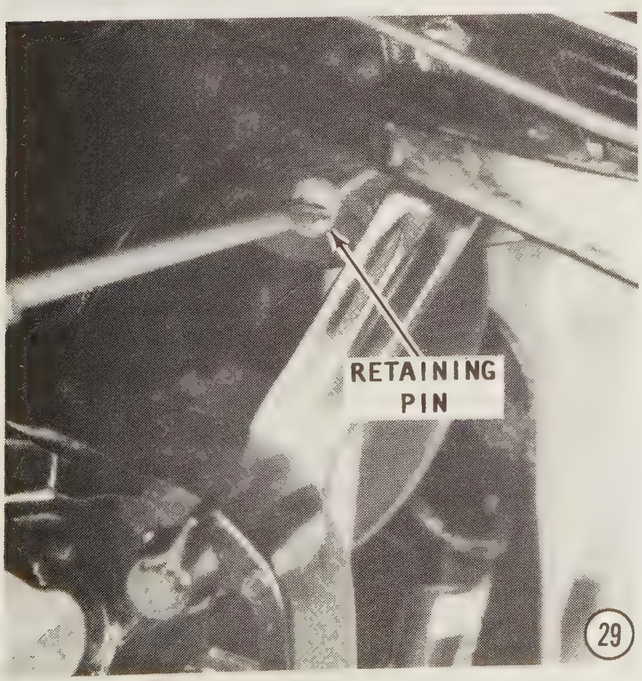
27- Carefully move the starboard clamp bracket into place with the manual release valve passing through the opening in the bracket. Start the three bolts securing the trim/tilt system to the starboard clamp bracket. Apply marine sealer to the shanks of the bolts securing the clamp bracket to the transom. The sealer is necessary to ensure a watertight installation. Install the bolts, lockwashers, and locknuts. Tighten the nuts securely. **NOW**, tighten the six trim/tilt system mounting bolts, three port

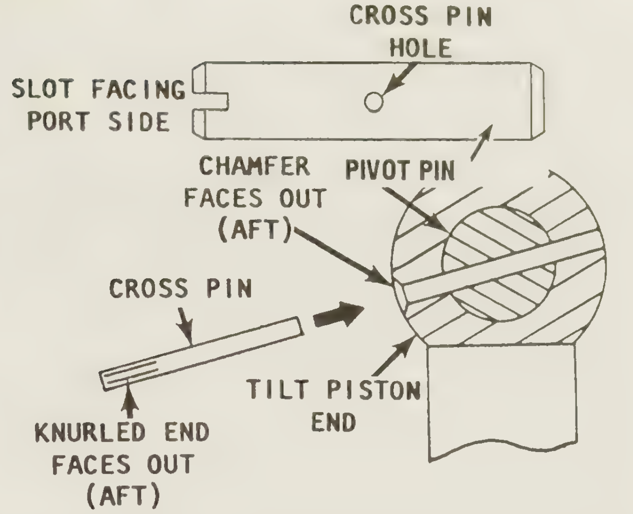




and three starboard, to a torque value of 30 ft. lbs. (40.7 Nm).

28- Connect the electrical leads to the **UP** and **DOWN** solenoids according to the tags affixed to the wires at the beginning of the disassembling procedures. If the tags were not affixed, refer to the electrical diagram in the Appendix. Connect the electrical leads to a 12-volt battery. Depress



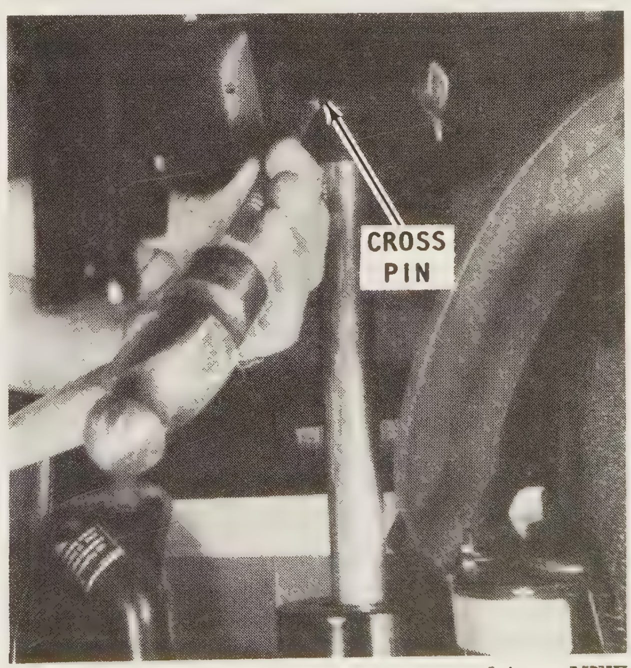


The retaining pin can be rotated with a large screwdriver until the hole in the pin is aligned with the hole in the end of the tilt piston. The chamfered hole in the end of the piston must face ***OUTWARD.*** *If it does not, remove the retaining pin and rotate the piston in the cylinder 1/2 turn.*

the **UP** button to extend the piston to the full up position.

29- Start the retaining pin into the port transom with the non-slotted end going in first.

Now, observe how the hole for the cross pin is aligned with the slot in the end of the retaining pin. Also note how the cross pin hole on one side of the retaining pin is chamfered and the other is not. Align the slot approximately with the hole in the end



Using a small punch and hammer to drive a ***NEW*** *cross pin into place,* ***AFTER*** *the hole has been aligned as indicated in the line drawing at the top of this column.*

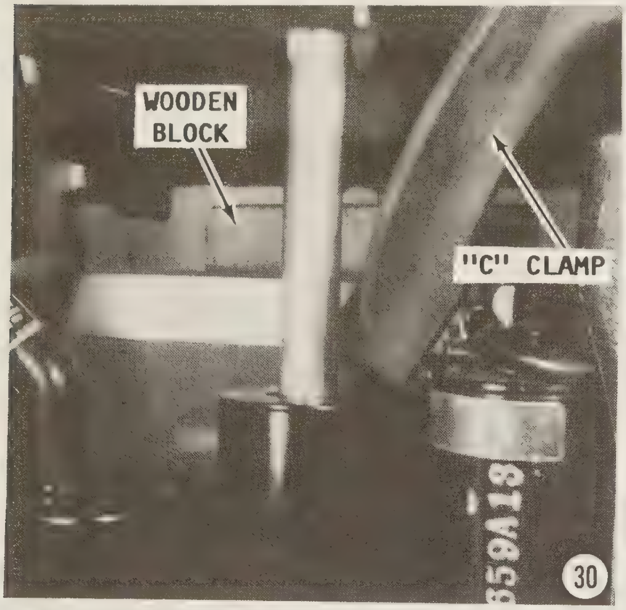
of the tilt piston, and then push the retaining pin through the port bracket, then the end of the tilt piston, and finally through the starboard bracket. Once the retaining pin is installed, rotate the pin very **SLOWLY** with a screwdriver until the hole in the retaining pin is aligned with the hole in the end of the tilt piston.

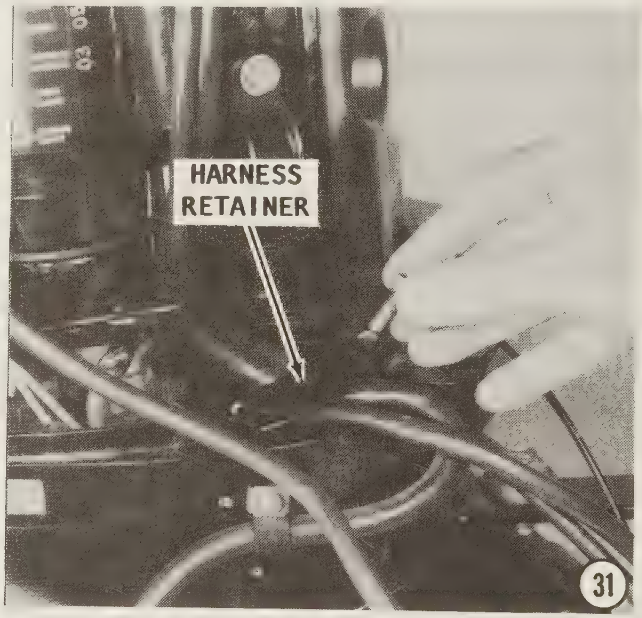
Once the hole is close to alignment, a small punch may be used through the hole in the piston end to rotate the retaining pin. After the hole is aligned, drive the cross pin into place with the smooth end of the cross pin going in first. Continue to drive the pin with a hammer and punch until the pin is flush with the surface of the piston end.

30- Remove the large C-clamp and block of wood. Remove the support safety tool by removing the cotter pins and pulling it free. Release the tilt lock lever, and then operate the system through several full cycles from full up to full down. Check the fluid level through the fill screw opening and add fluid as required. Bleed the system of air.

31- Install the harness retainer and secure it with the attaching bolts. If any other wire clamps were removed, install and tighten them securely.

Apply Quicksilver Liquid Neoprene, or equivalent, on all electrical connections as a waterproof measure.





11 REMOTE CONTROLS

11-1 INTRODUCTION

Boat accessories are seldom obtained from the original equipment manufacturer. Shift boxes, steering arrangements, bilge pumps, blowers, and other similar equipment may be added by the boat manufacturer. Because of the wide assortment, styles, and price ranges of such accessories, the boat manufacturer, or customer, has a wide selection from which to draw, when outfitting the boat.

Therefore, the procedures and suggestions in this chapter are general in nature in order to cover as many units as possible, but still specific and in enough detail to allow troubleshooting repair, and adjustment of these accessories for maximum comfort, performance and safety.

11-2 CHAPTER ORGANIZATION

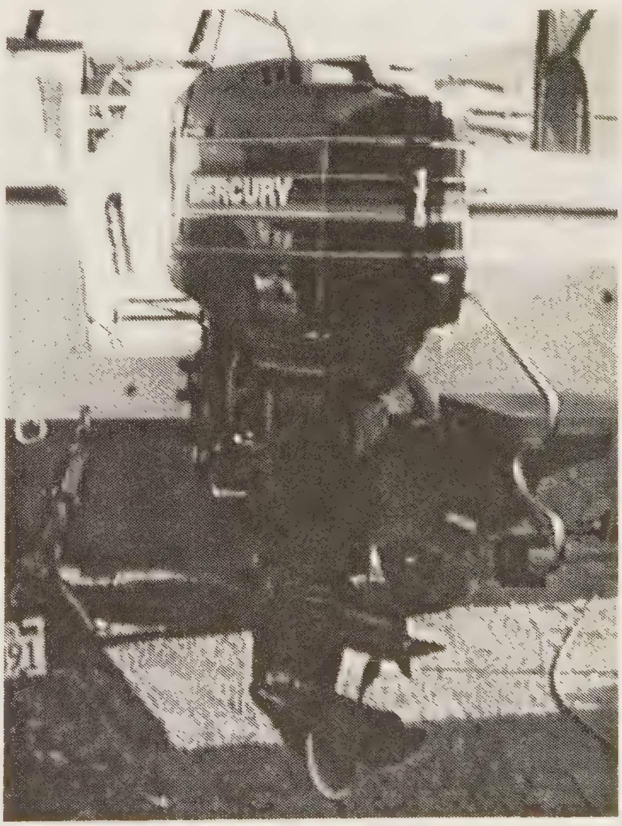
Would you believe: Probably 90% of steering cable problems are directly caused by the system not being operated, just sitting idle during the off-season. Without movement, all steering cables have a tendency to "freeze". **Would you also believe:** Service shops report almost 50% of boat cables are replaced every year, due to lack of movement. Therefore, during off-season when the boat is laid up in a yard, or on a trailer alongside the house, take time to go aboard and operate the steering wheel from hard-over to hard-over several times.

Proper cable length determination for the standard Ride Guide and for the Universal Ride Guide is explained in this section. Service procedures for the rotary steering system are presented in Section 11-3.

The Standard Ride Guide and Custom Ride Guide kits are explained in Section 11-4 and 11-5 respectively.

Detailed service procedures for the Commander shift control box are in Section 11-6.

These sections provide step-by-step service instructions. Disassembly may be stopped at any point desired and the assembly process begun. For best results and maximum performance, the entire system should be serviced if any one part is disassembled for repair.



Non-use is the greatest enemy of the remote control system. The steering mechanism should be operated at regular intervals during the "off-season" to ensure all parts will function properly when the boat is again ready for service on the water.

GOOD WORDS

If the control cable has a "Zerk" fitting at the engine end, the cable **MUST** be retracted, then the fitting lubricated with Quicksilver Multi-Purpose lubricant or Quicksilver 2-4C Lubricant.

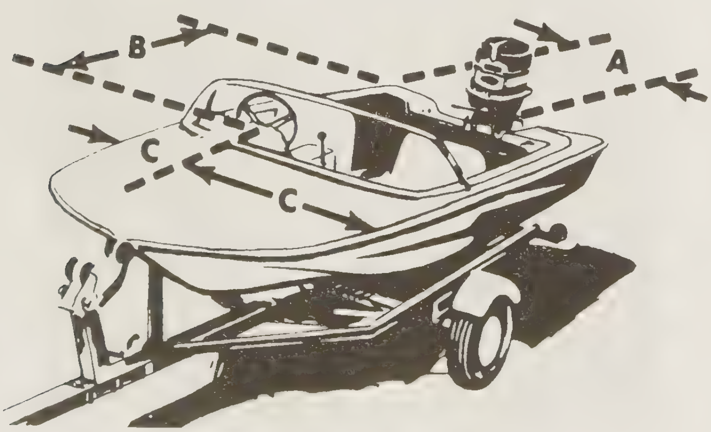
STEERING CHECKS

The steering system may be checked by performing a few very simple tests. First, move the steering wheel from hard-over to hard-over port and starboard several times. The outboard unit should move without any sign of stiffness. If binding or stiffness is encountered, the cause may be a defect in the swivel bearing.

Next remove the steering bolt at the outboard unit, and again turn the steering wheel back-and-forth from hard-over to hard-over port and starboard several times. If there is any sign of stiffness, it is proof the problem is with the cables. They may be corroded or there may be a defect in the steering mechanism.

To determine the proper cable length for the Standard Ride Guide or for the Universal Ride Guide, a few measurements plus some simple arithmetic will provide the correct answer. Refer to the accompanying illustration for the letter measurement identification as follows:

A- Equals the distance, in inches (or cm), from the Ride Guide attachment on the outboard unit to the side (inside) of the boat.



Drawing indicating the three dimensions required to accurately determine the proper length of steering cables needed for any boat. The letter designations given are standard and are mentioned and explained in the text.

B- Equals distance, in inches (or cm), from the inside rear of the boat to the control panel.

C- Equals the distance, in inches (or cm), from the centerline of the steering wheel hub to the side (inside) of the boat. This measurement is taken in the same manner for a right-hand or left-hand installation.

Now, add boat measurements A, B, and C.

Subtract 30" (76.2 cm), for a Standard Ride Guide installation.

or

Subtract 39" (99.1 cm), for a Universal Ride Guide installation.

This subtraction allows for 12" (30.5 cm), radii at each cable bend.

Divide by 12 for the length in feet.

The answer is the cable length or assembly suffix number for the proper installation on your boat.

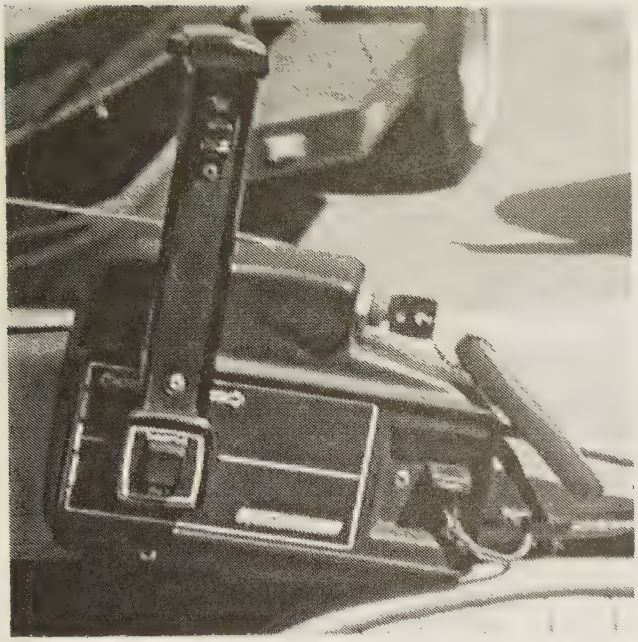
11-3 ROTARY STEERING SERVICE

Because there are so many different styles and variations of rotary steering systems, a couple of quick checks are given below to determine if disassembly of the system is required. Check and/or lubricate all pivot points with SAE 30W motor oil. Lubricate the steering cable zerk fitting, at the outboard end of the cable, with the cables fully retracted. Use Mercury 2-4-C Marine lubricant, or an equivalent, water proof type lubricant. Check the full length of the cable routing. Be especially watchful for sharp bends or kinks in the cable.

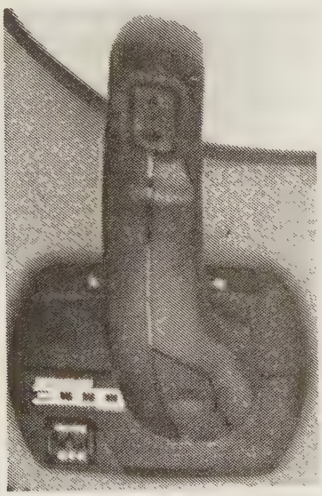
Steering Check:

The steering system may be checked by moving the steering lever back-and-forth from hard-over to hard-over several times. The engine should move without any sign of stiffness. If binding or stiffness is encountered the cause may be defective bearings in the swivel bearing.

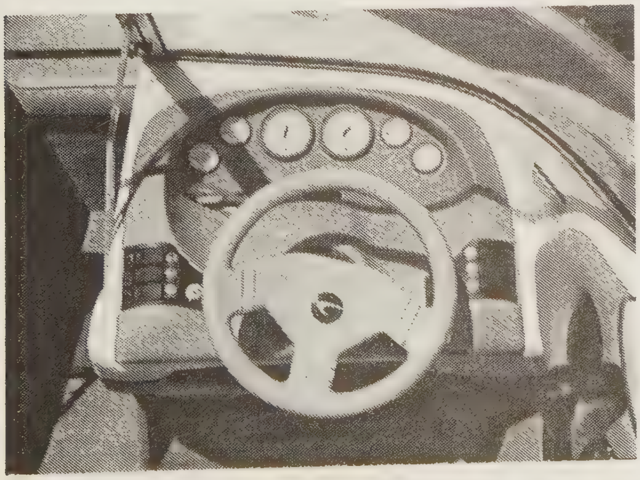
The steering cable may be checked by first disconnecting the steering cable at the engine, and then turning the steering wheel back and forth from hard-over to hard-over several times. If there is any sign of stiffness, the cables may be corroded or there may be a defect in the steering mechanism.



Mercury Commander 2000 remote control unit. This unit is serviced later in this chapter.



Late model Mercury Commander 3000 remote control unit.



Typical rotary steering installation. Rotary steering is not considered part of the outboard package. In almost all cases it is installed by the boat manufacturer.

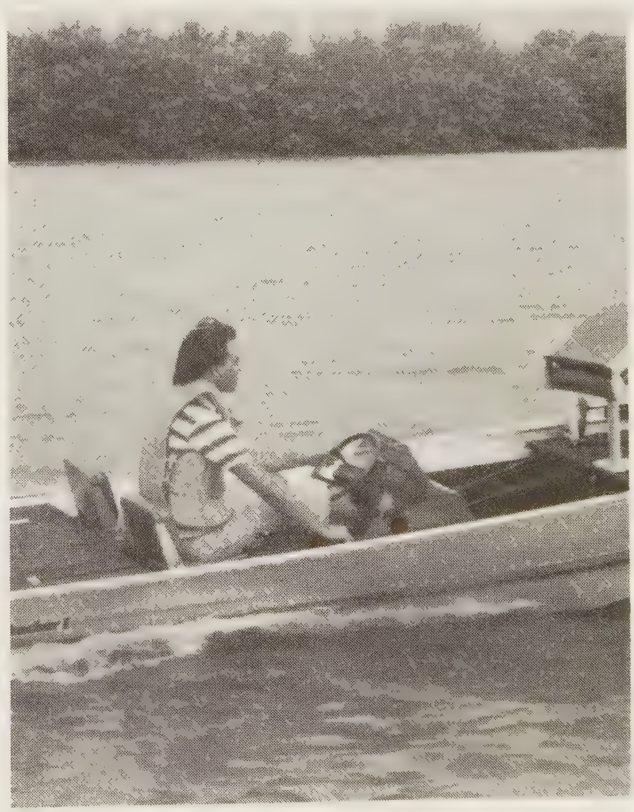
11-4 STANDARD RIDE GUIDE KIT

Steering kits are available from the local marine dealer to convert a boat from engine tiller steering to a wheel arrangement on a control panel. Most of the hardware required for the complete installation is included in the kit.

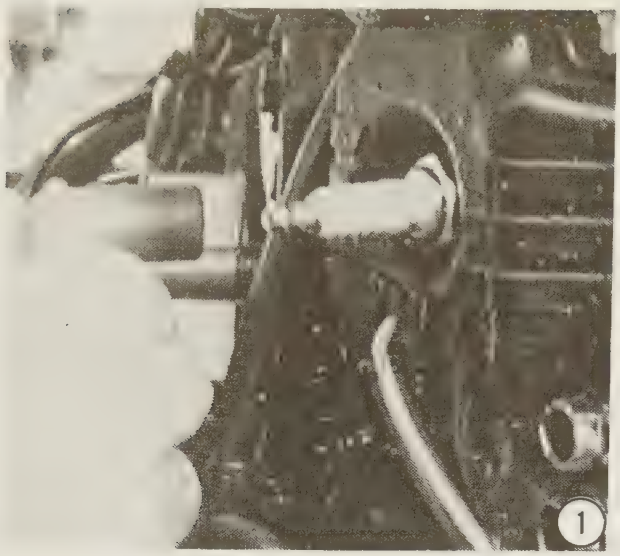
To determine the size Standard Ride Guide kit necessary for the boat to be converted, refer to Section 11-2. An illustration and the simple arithmetic involved are outlined in detail.

11-5 CUSTOM RIDE GUIDE KITS

Custom kits are vailable for a wide range of outboard models. The kits differ according to the model year, and whether the unit is electric or manual start. Special kits are available for dual outboard installations. In addition to all the parts necessary for an installation, complete detailed instructions are included along with a practical maintenance schedule.



A remote control steering and shift box installation -- a standard Ride Guide or custom kit -- can certainly add comfort and additional enjoyment to the day on the water.

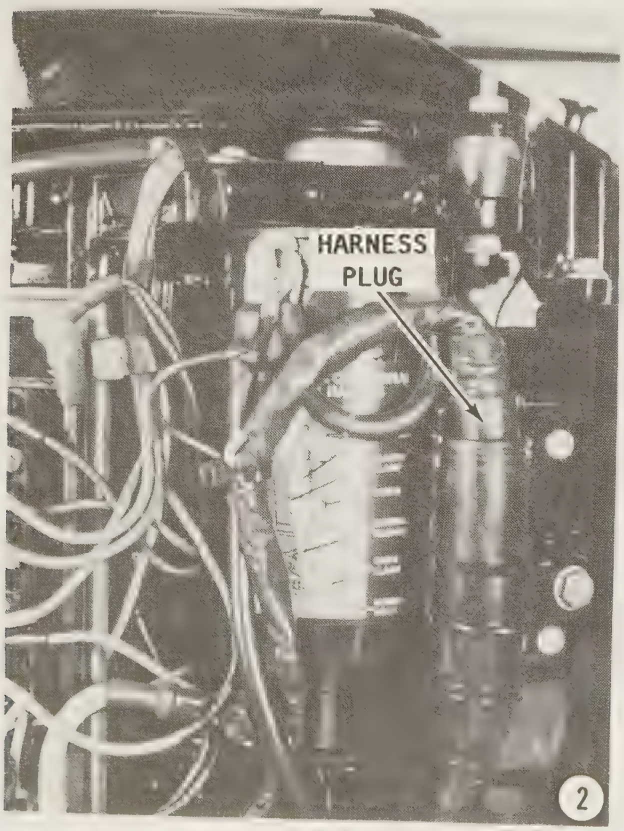


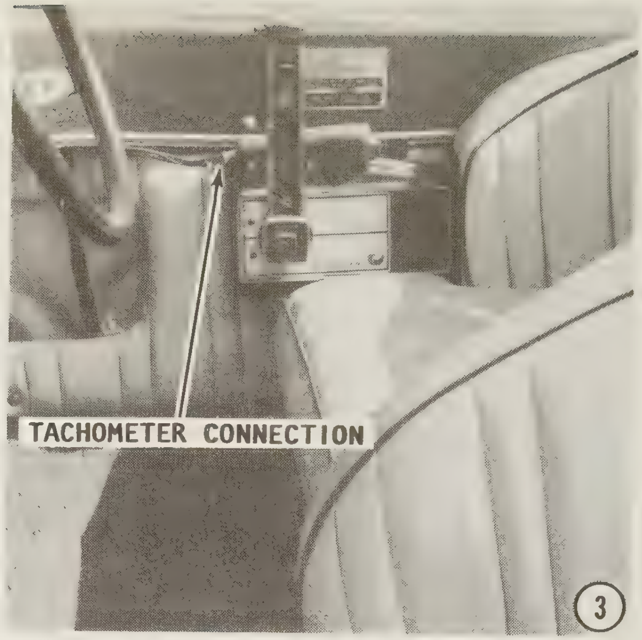
11-6 COMMANDER CONTROL SHIFT BOX SERVICE

REMOVAL AND DISASSEMBLING

The following detailed instructions cover removal and disassembly of the "Commander" control shift box from the mounting panel in the boat.

1- Turn the ignition key to the **OFF** position. Disconnect the high tension leads from the spark plugs, with a twisting motion.

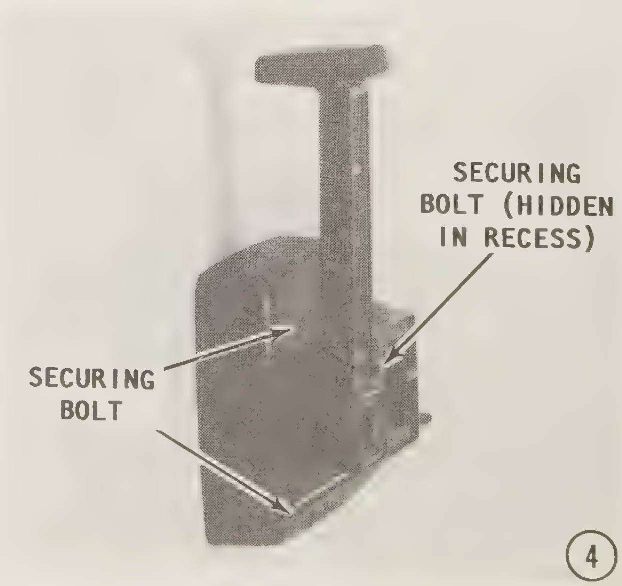


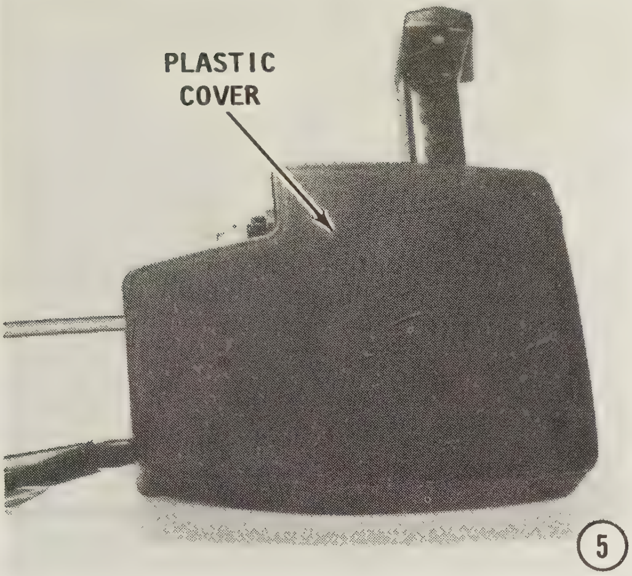


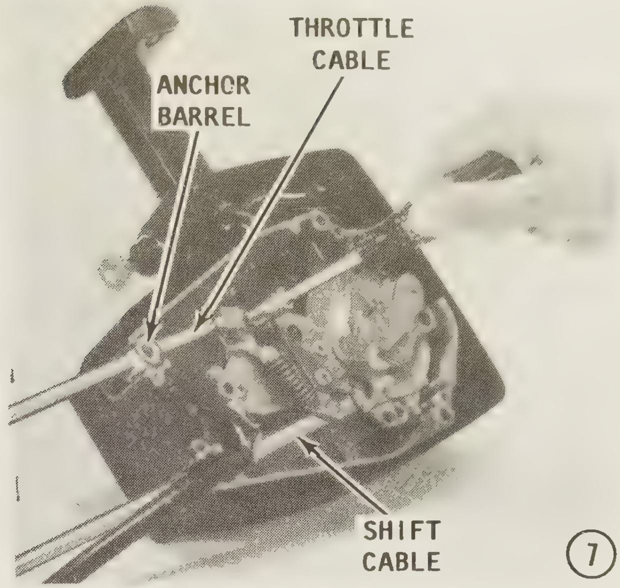
2- Disconnect the remote control wiring harness plug from the outboard trim/tilt motor and pump assembly.

3- Disconnect the tachometer wiring plug from the forward end of the control housing.

4- Remove the three locknuts, flat washers, and bolts securing the control housing to the mounting panel. One is located next to the **RUN** button (the ignition safety stop switch), and the second is beneath the control handle on the lower portion of the plastic case. The third is located behind the control handle when the handle is in the **NEUTRAL** position. Shift the handle into **FORWARD** or **REVERSE** position to remove the bolt, then shift it back into the **NEUTRAL** position for the following steps.







5- Pull the remote control housing away and free of the mounting panel. Remove the plastic cover from the back of the housing. Lift off the access cover from the housing. (Some "Commander" remote control units do not have an access cover.)

6- Remove the two screws securing the cable retainer over the throttle cable, wiring harness, and shift cable. Unscrew the two Phillips-head screws securing the back cover to the control module, and then lift off the cover.

Throttle Cable Removal

7- Loosen the cable retaining nut and raise the cable fastener enough to free the throttle cable from the pin. Lift the cable from the anchor barrel recess.

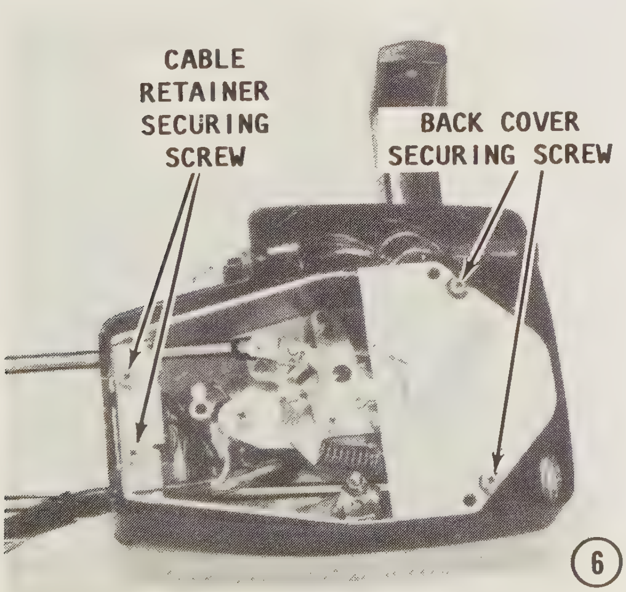
8- Remove the grommet.

Shift Cable Removal

9- Shift the outboard unit into **REVERSE** gear by depressing the neutral lock bar on the control handle and moving the control handle into the **REVERSE** position. **LOOSEN**, but do not remove, the shift cable retainer nut with a 3/8" deep socket as far as it will go without removing it. Raise the shift cable fastener enough to free the shift cable from the pin.

DO NOT attempt to shift into **REVERSE** while the cable fastener is loose. An attempt to shift may cause the cable fastener to strike the neutral safety microswitch and cause it damage.

Lift the wiring harness out of the cable anchor barrel recess and remove the shift cable from the control housing.



Control Handle Removal For Power Trim/Tilt With Toggle Trim Switch Or Push-Button Trim Switch

GOOD WORDS

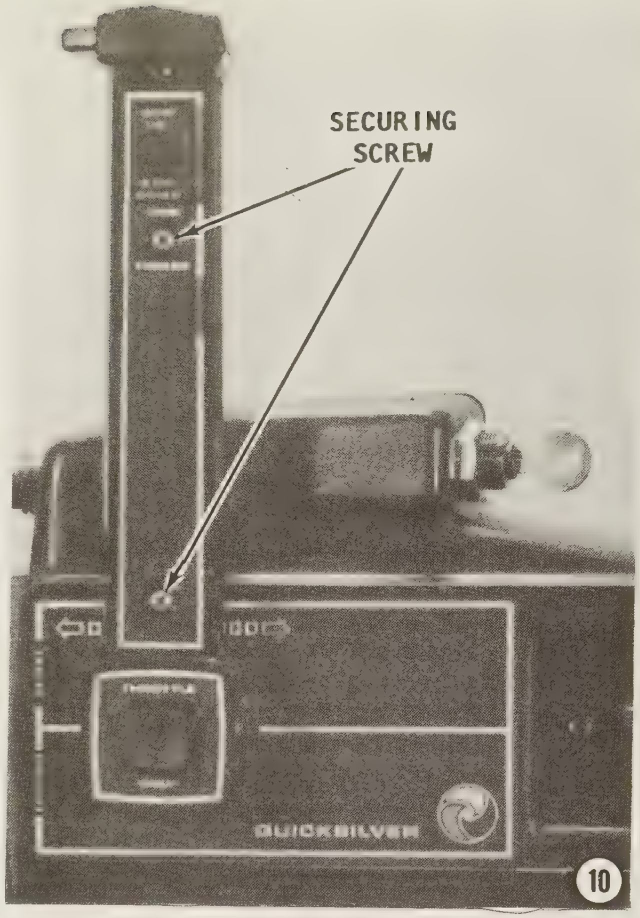
For non-power trim/tilt units, it is not necessary to remove the cover of the control handle. If servicing one of these units. proceed directly to Step 13. All others perform Steps 10 thru 12.

10- Depress the **NEUTRAL** lock bar on the control handle and shift the control handle back to the **NEUTRAL** position. Remove the two Phillips head screws which secure the cover to the handle, and then lift off the cover. The push button trim switch will come free with the cover, the toggle trim switch will stay in the handle body.

Unsnap and then remove the wire retainer. Carefully unplug the trim wires and straighten them out from the control panel hub for ease of removal later.

11- Back-off the set screw at the base of the control handle to allow the handle to be removed from the splined control shaft.

12- Grasp the "throttle only" button and pull it off the shaft.



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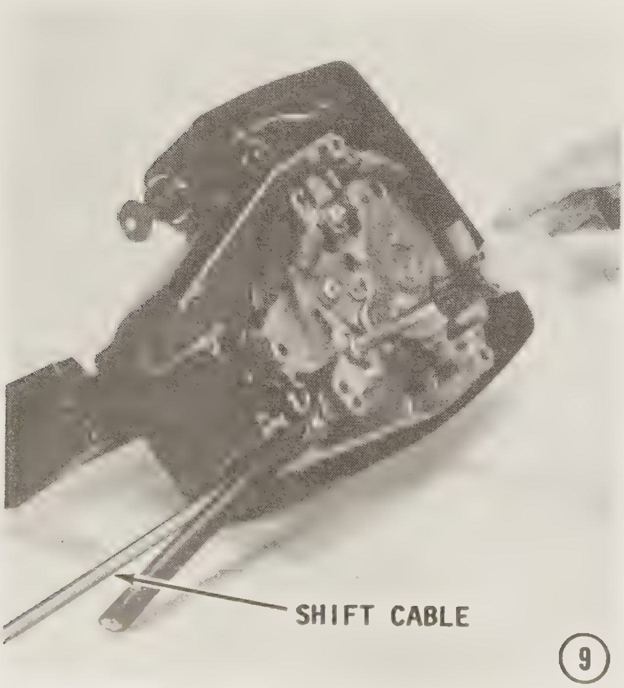
SPECIAL WORDS

Take care not to damage the trim wires when removing the control handle, on power trim models.



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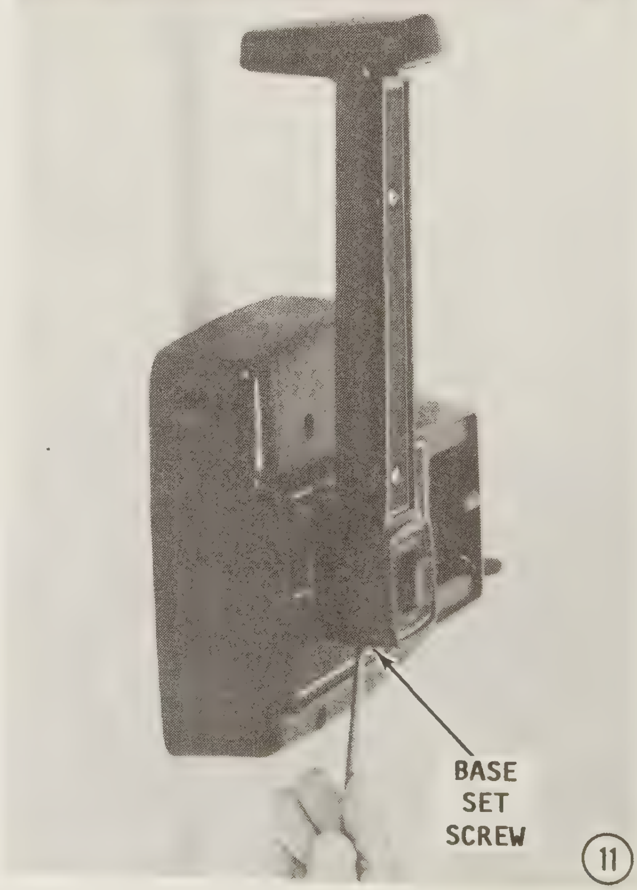

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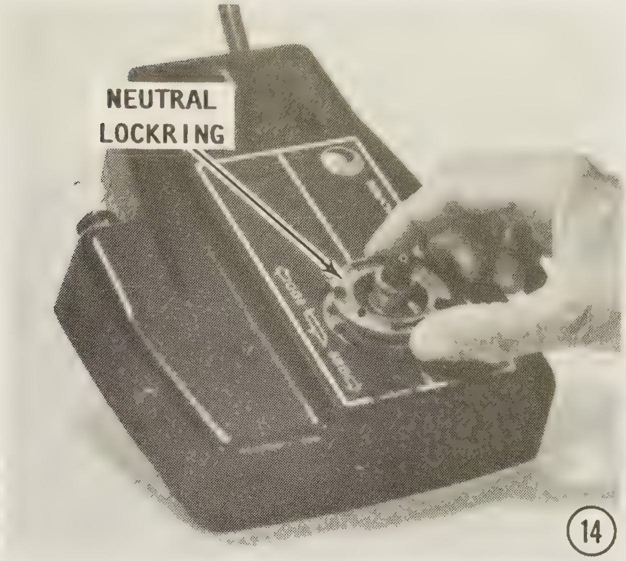
13- Remove the control handle.

14- Lift the neutral lockring from the control housing.

TAKE CARE to support the weight of the control housing to avoid placing any unnecessary stress on the control shaft during the following disassembling steps.

15- Remove the three Phillips-head screws securing the control module to the plastic case. Two are located on either side of the bearing plate and one is in the recess where the throttle cable enters the control housing.



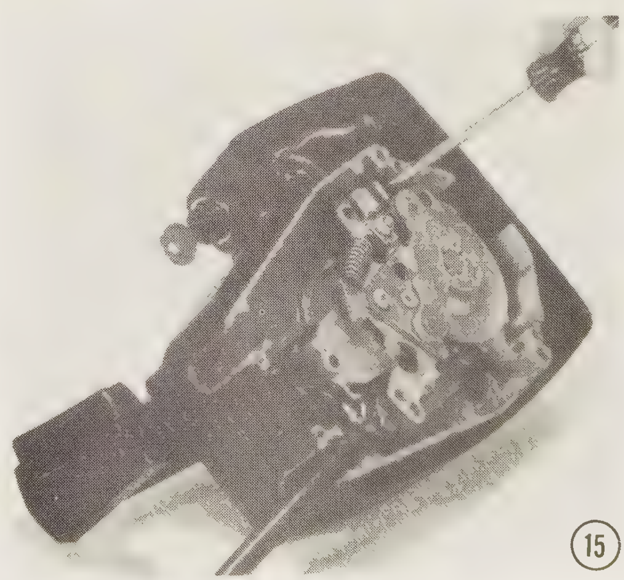
16- Back-out the detent adjustment screw and the control handle friction screw until their heads are flush with the control module casing. This action will reduce the pre-load from the two springs on the detent ball for later removal.

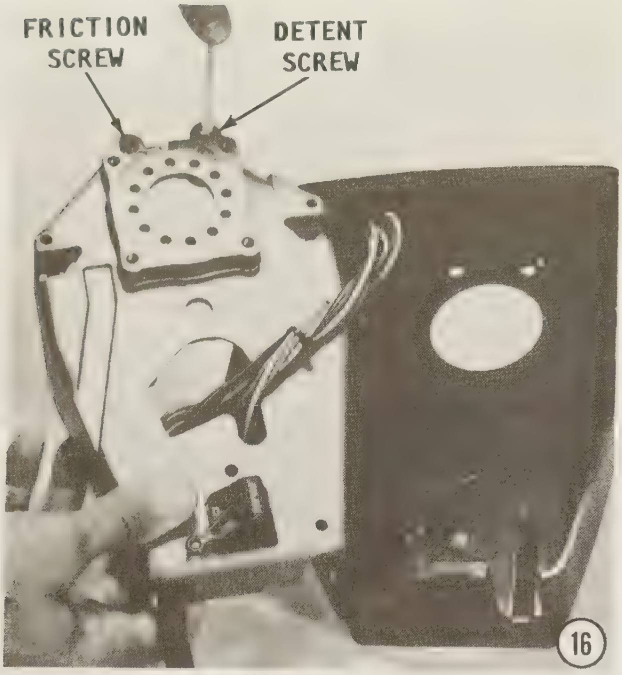
GOOD WORDS

As this next step is performed, count the number of turns for each screw as they are backed-out and record the figure somewhere. This will be a tremendous aid during assembling.

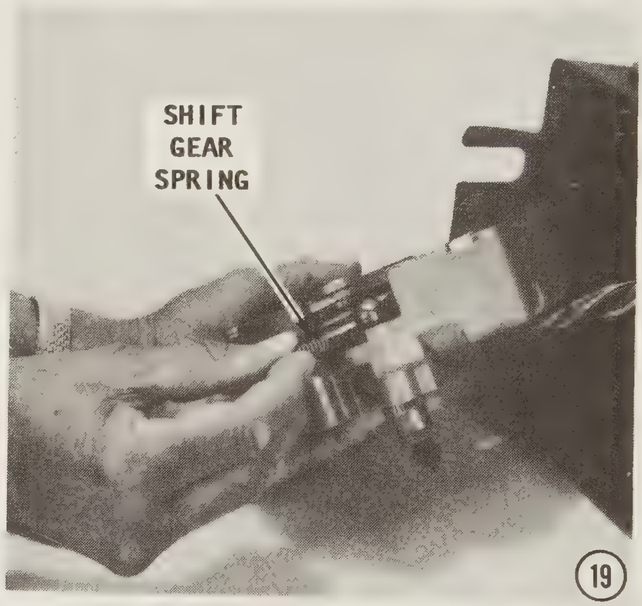
17- Remove the two locknuts securing the neutral safety switch to the plate assembly and lift out the micro-switch from the recess in the assembly.

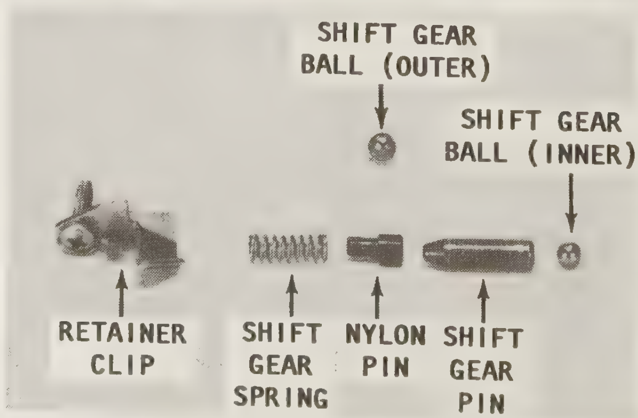
18- Remove the Phillips-head screw securing the retaining clip to the control module.



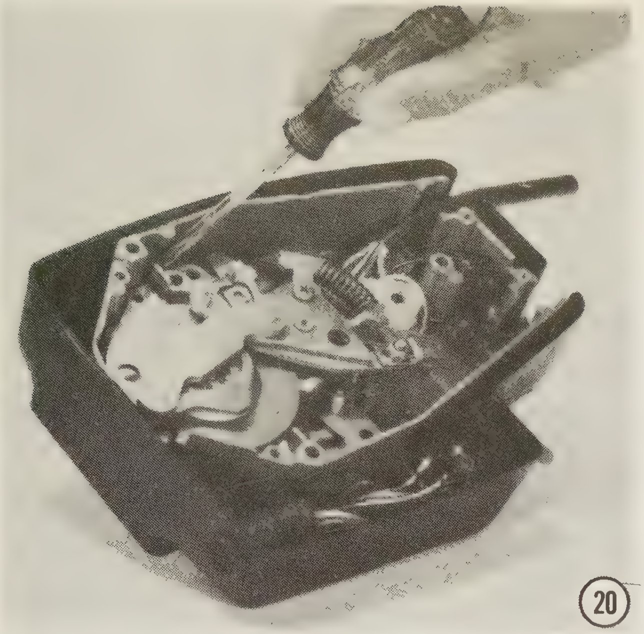


19- Support the module in your hand and tilt it until the shift gear spring, shift nylon pin (earlier models have a ball), shift gear pin, another ball the shift gear ball (inner), fall out from their recess. If the parts do not fall out into your hand, attach the control handle and ensure the unit is in the **NEUTRAL** position. The parts should come free when the handle is in the **NEUTRAL** position.





Arrangement of parts from the control module recess. As the parts are removed and cleaned, keep them in order, ready for installation.



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20- Remove the three Phillips-head screws securing the bearing plate assembly to the control module housing.

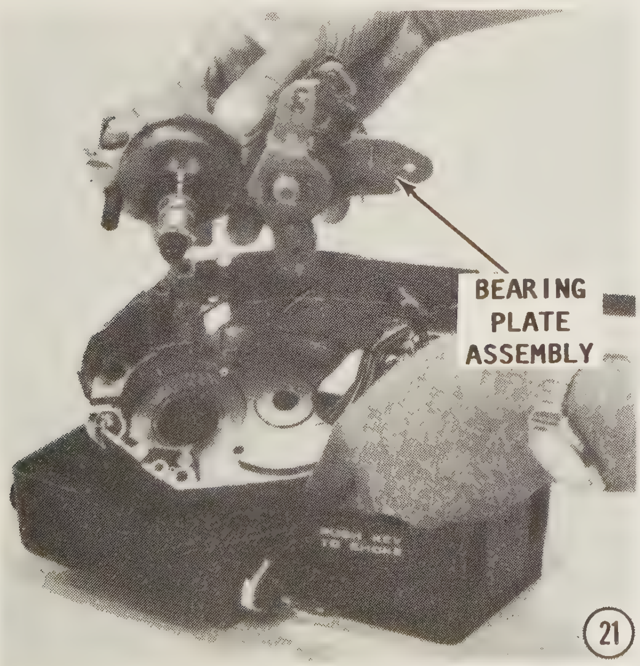
21- Lift out the bearing plate assembly from the control module housing.

Power Trim/Tilt Units Only

22- Uncoil the trim wires from the recess in the remote control module housing and lift them away with the trim harness bushing attached.

All Units

23- Remove the detent ball, the detent ball follower, and the two compression



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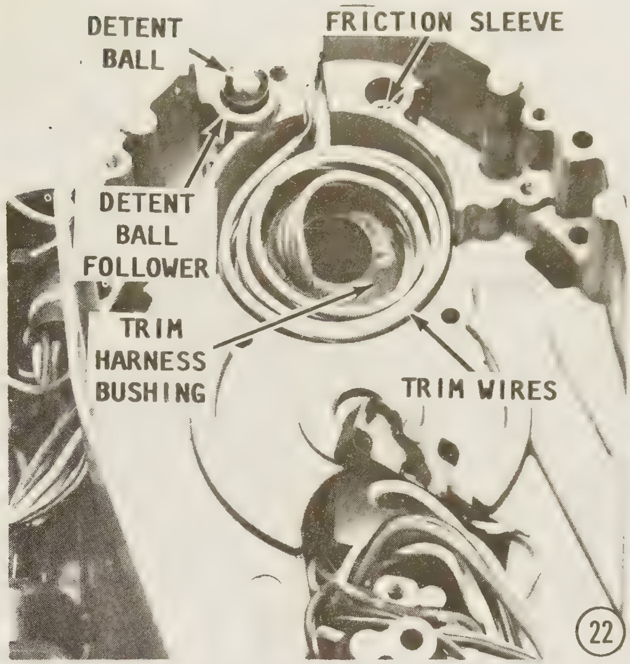

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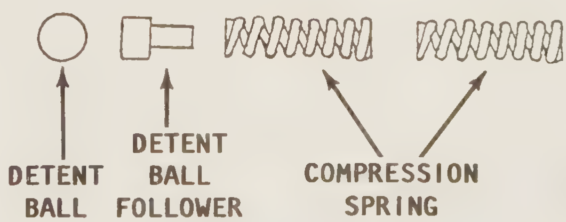
springs (located under the follower), from their recess in the control module housing.

24- If it is not part of the friction pad, remove the control handle friction sleeve from the recess in the control module housing.

25- Pull the throttle link assembly from the module. Remove the compression spring from the throttle lever. It is not necessary to remove this spring unless there is cause to replace it. At this point, there is the



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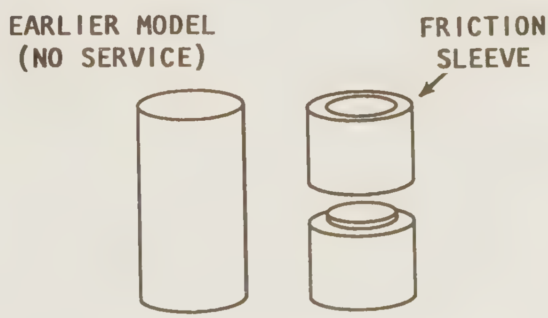

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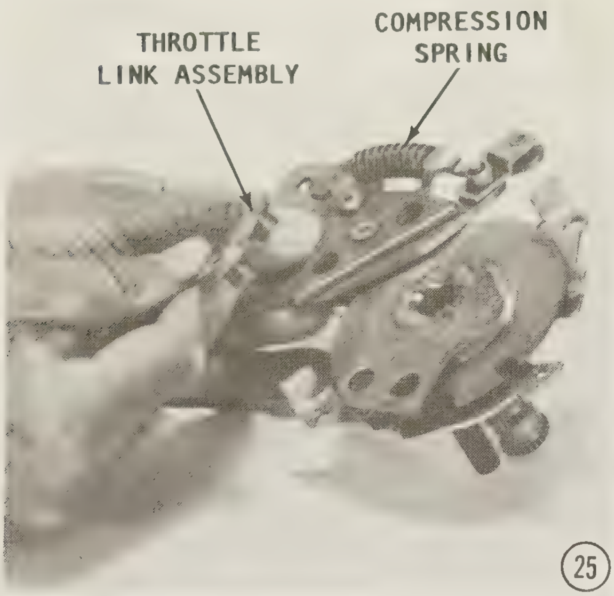

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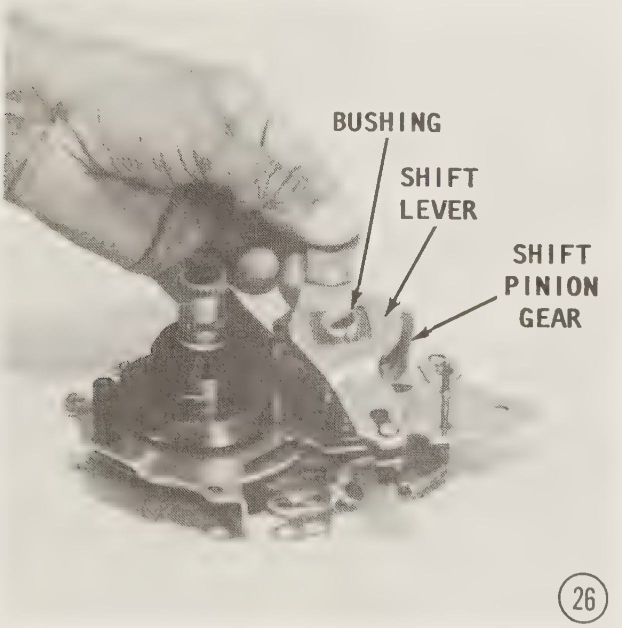
least amount of tension on the compression spring. Therefore, now would be the time to replace it, if required.

26- Lift the shift pinion gear (with attached shift lever), off the pin on the bearing plate. The nylon bushing may come away with the shift lever or stay on the pin. Remove the shift lever and shift pinion gear as an assembly. **DO NOT** attempt to separate them. Both are replaced if one is worn.

Non-Power Trim/Tilt Units Only

27- Remove the trim harness bushing and wiring harness retainer from the control shaft. (On non-power trim/tilt units these two items act as spacers.)



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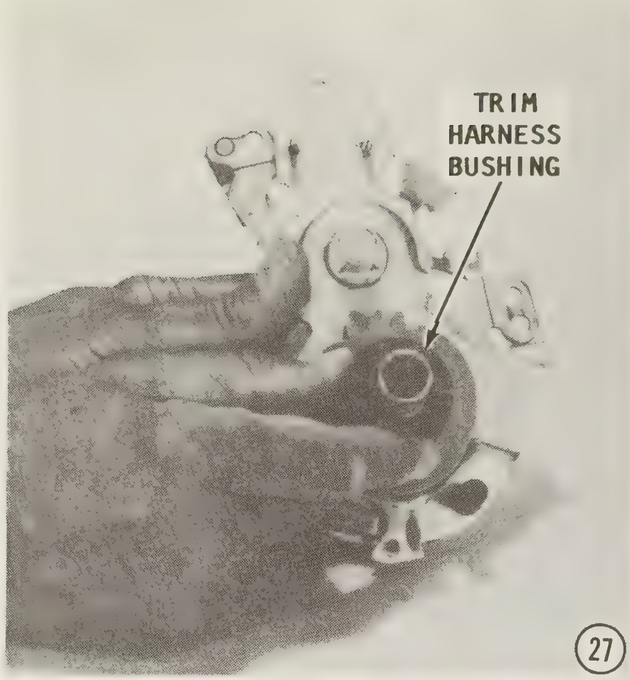

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All Units

28- Remove the shift gear retaining ring from its groove with a pair of Circlip pliers.

SPECIAL WORDS

If the Circlip slipped out of its groove, this would allow the shift gear to ride up on the shaft and cause damage to the small parts contained in its recess. The shift gear ball (inner), the shift gear pin, the shift gear ball (outer), or the nylon pin and **PARTICULARLY** the shift gear spring **MUST** be inspected closely.

28

29

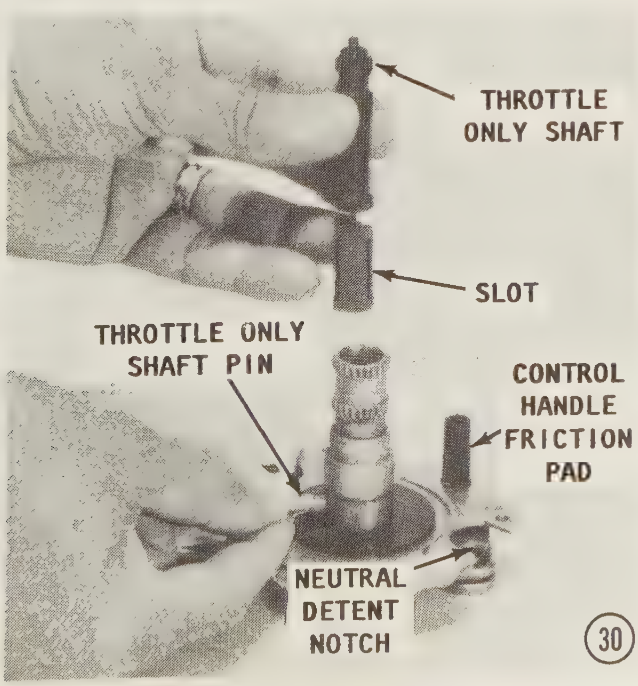
29- Lift the gear from the control shaft.

30- Remove the "throttle only" shaft pin and "throttle only" shaft from the control shaft.

31- Remove the step washer from the base of the bearing plate.

CLEANING AND INSPECTING

Clean all metal parts with solvent, and then blow them dry with compressed air.



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NEVER allow nylon bushings, plastic washers, nylon pins, wiring harness retainers, and the like, to remain submerged in solvent more than just a few moments. The solvent will cause these type parts to expand slightly. They are already considered a "tight fit" and even the slightest amount of expansion would make them very difficult to install. If force is used, the part is most likely to be distorted.

Inspect the control housing plastic case for cracks or other damage allowing moisture to enter and cause problems with the mechanism.

Carefully check the teeth on the shift gear and shift lever for signs of wear. Inspect all ball bearings for nicks or grooves which would **CAUSE** them to bind and fail to move freely.

Closely inspect the condition of all wires and their protective insulation. Look for exposed wires caused by the insulation rubbing on a moving part, cuts and nicks in the insulation and severe kinking which could cause internal breakage of the wires.

Inspect the surface area above the groove in which the Circlip is positioned for signs of the Circlip rising out of the groove. Such action would occur if the clip had lost its "spring" or if it had worn away the top surface of the groove. If the Circlip slipped out of its groove, the shift gear would be able to ride up on the shaft and cause damage to the small parts contained in its recess.

The shift gear ball (inner), the shift gear pin, the shift gear ball (outer), or the nylon pin and **PARTICULARLY** the shift gear spring **MUST** be inspected closely.

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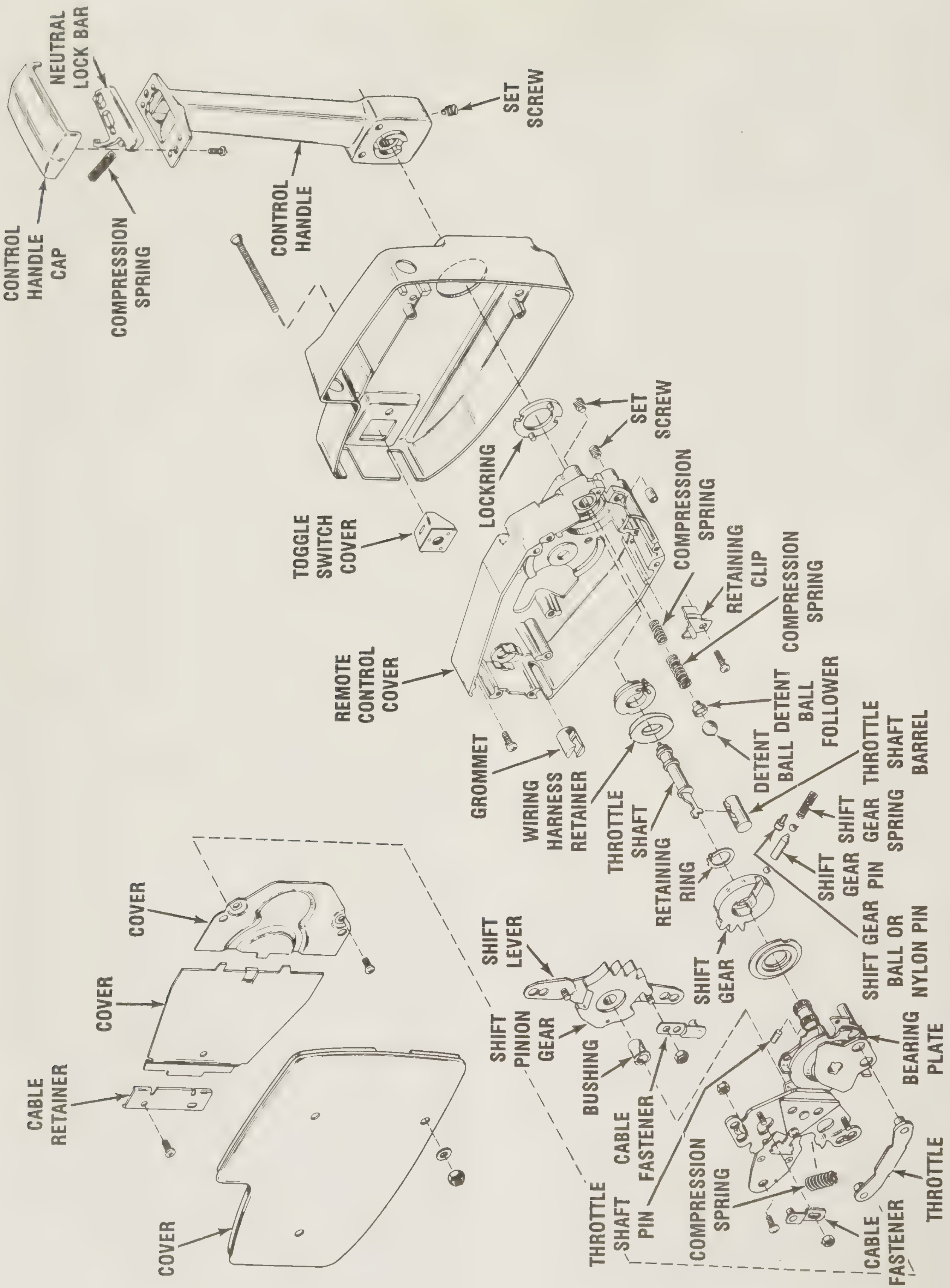
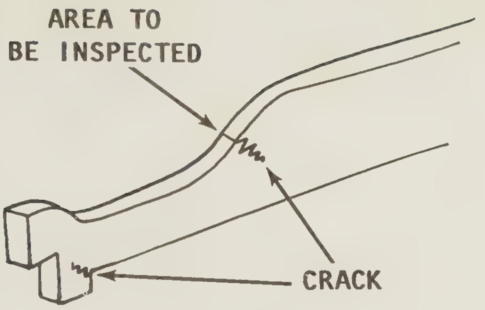


Exploded drawing of the Commander shift box with major parts identified.



The throttle-only shaft should be inspected for wear along the ramp, as indicated.

Inspect the "throttle only" shaft for wear along the ramp. In early model units, this shaft was made of plastic. Later models have a shaft of stainless steel. Check for excessive wear or cracks on the ramp portion of the shaft, as indicated in the accompanying illustration. Also check the lower "stop" tab to be sure it has not broken away.

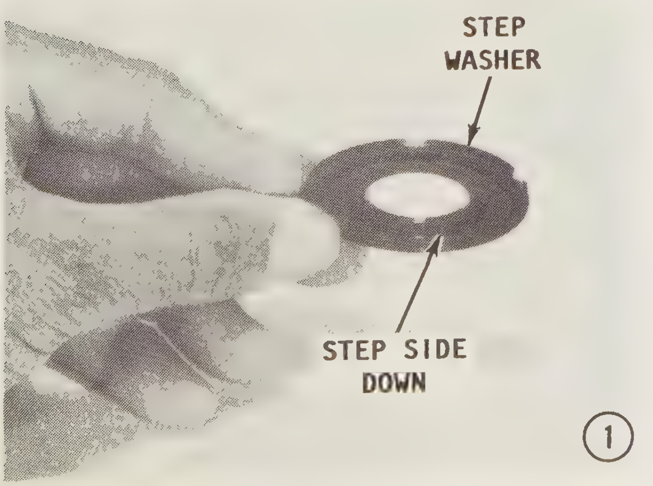
SPECIAL WORDS

Good shop practice dictates a thin coat of Multipurpose Lubricant be applied to all moving parts as a precaution against the "enemy" moisture. Of course the lubricant will help to ensure continued satisfactory operation of the mechanism.

ASSEMBLING AND INSTALLATION COMMANDER CONTROL SHIFT BOX

FIRST, THESE WORDS

The Commander control shift box, like others, has a number of small parts that



MUST be assembled in only one order -- the proper order. Therefore, the work should not be "rushed" or attempted if the person assembling the unit is "under pressure". Work slowly, exercise patience, read ahead before performing the task, and follow the steps closely.

If necessary take a "break". Have a cup of coffee, tea, short snort of rum, whatever, and then continue with the assembling.

1- Place the step washer over the control shaft and ensure the steps of the washer seat onto the base of the bearing plate.

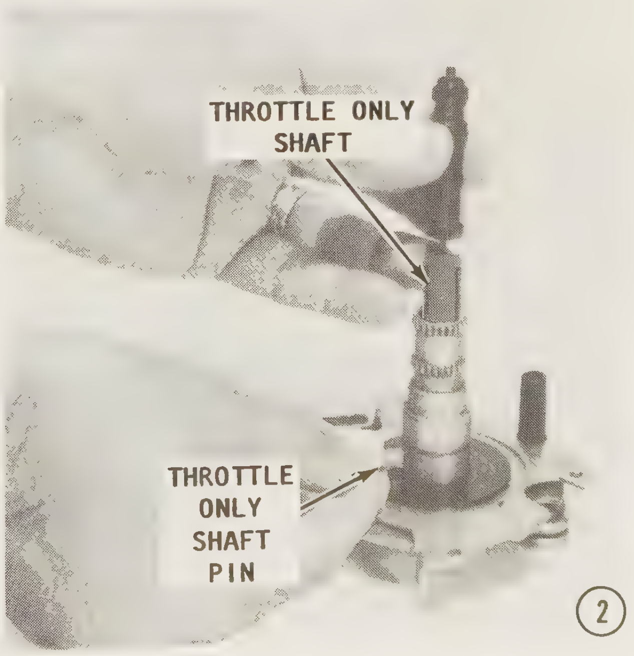
2- Rotate the control shaft until the "throttle only" shaft pin hole is aligned centrally between the neutral detent notch and the control handle friction pad. Lower the "throttle only" shaft into the barrel of the control shaft. Secure the shaft in this position with the "throttle only" shaft pin.

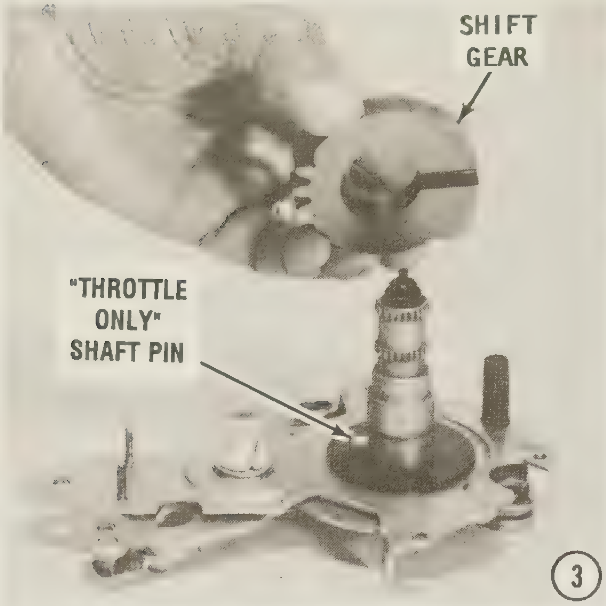
SPECIAL WORDS

When the pin is properly installed, it should protrude slightly in line with the plastic bushing.

Make an attempt to gently pull the "throttle only" shaft out of the control shaft. If the shaft and pin are properly installed, the attempt should fail.

3- Place the shift gear over the control shaft, and check to be sure the "throttle only" shaft pin clears the gear.





4- Install the retaining ring over the control shaft with a pair of Circlip pliers. Check to be sure the ring snaps into place within the groove.

Non-Power Trim/Tilt Units Only

5- Slide the wiring harness retainer and the trim harness bushing over the control shaft. The trim harness bushing is placed "stepped side" **UP** and the notched side toward the forward side of the control housing.

Power Trim/Tilt Units Only

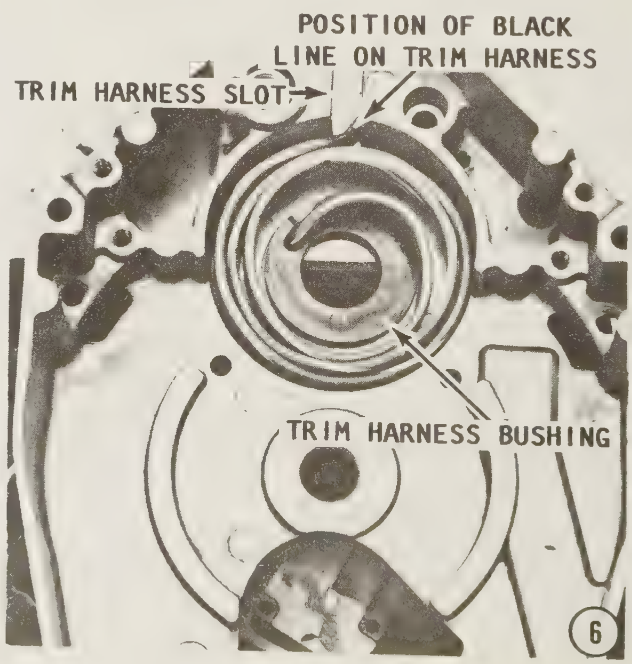
6- Insert the trim harness bushing into the recess of the remote control housing and

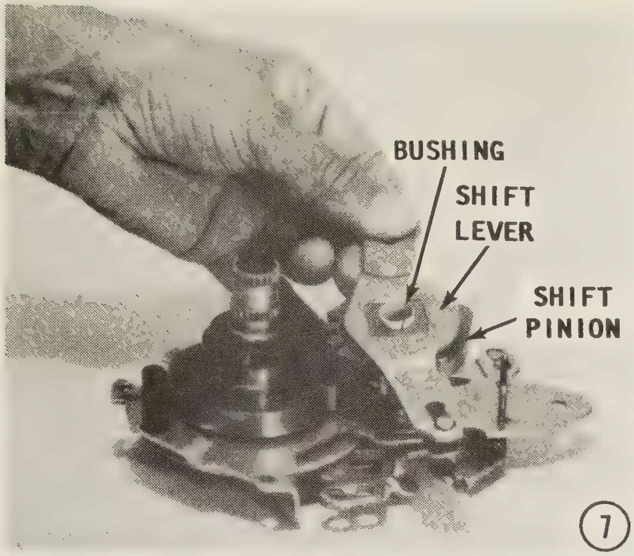
carefully coil the wires, as shown in the accompanying illustration. Ensure the black line on the trim harness is positioned at the exact point shown for correct installation. The purpose of the coil is to allow slack in the wiring harness when the control handle is shifted through a full cycle. The bushing and wires move with the handle.

All Units

7- Position the bushing, shift pinion gear and shift lever onto the pin on the bearing plate, with the shift gear indexing with the shift pinion gear.

8- Install the two compression springs,





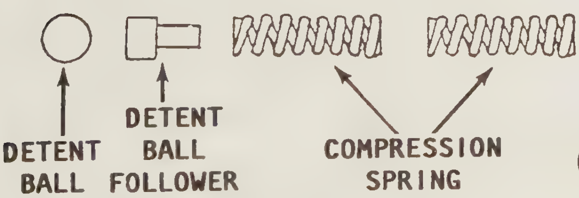
7

the detent ball follower and the detent ball into their recess in the control module housing.

9- If the friction sleeve is not a part of the friction pad, then place the control handle friction sleeve into its recess in the control module housing.

SPECIAL WORDS

In Step 16 on Page 11-7, of the disassembling procedures, instructions were given to count the number of turns required to remove the detent adjustment screw and the control handle friction screw. The number of turns is now necessary for ease in performing the next step.



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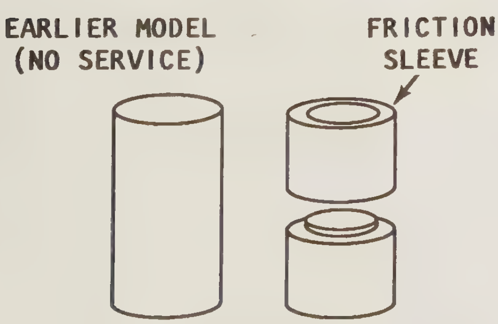

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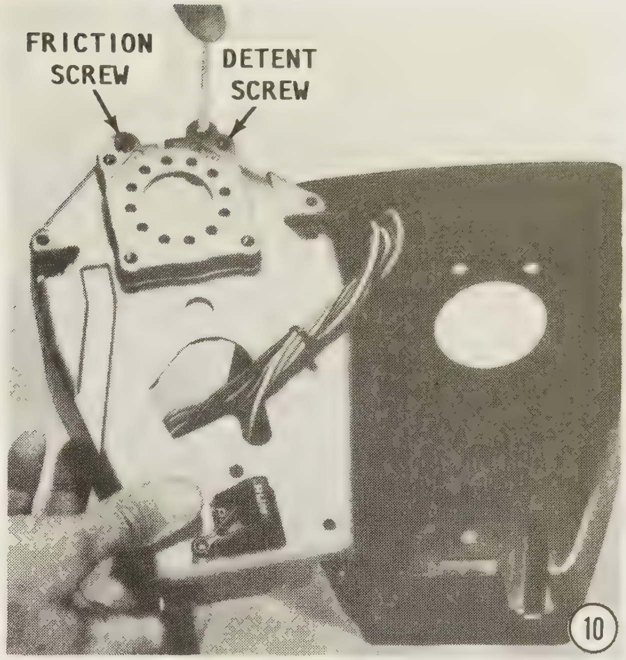

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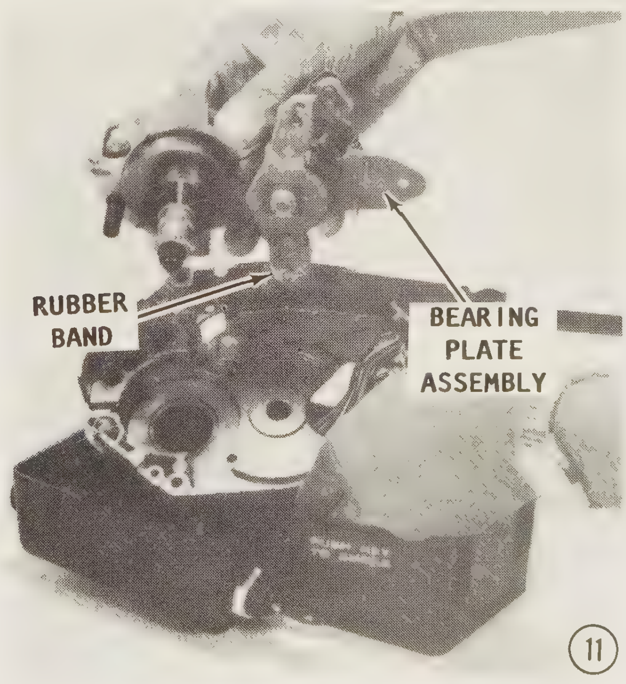
10- Thread the detent adjustment screw and the control handle friction screw the exact number of turns as instructed and recorded under the "Good Words" prior to Step 17 of disassembling. A fine adjustment may be necessary after the unit is completely assembled.

11- Place the compression spring (if removed), in position on the shift lever and shift pinion gear assembly against the bearing plate, as shown. Use a rubber band to secure the shift pinion gear to the bearing plate. Lower the complete bearing plate assembly into the control module housing.



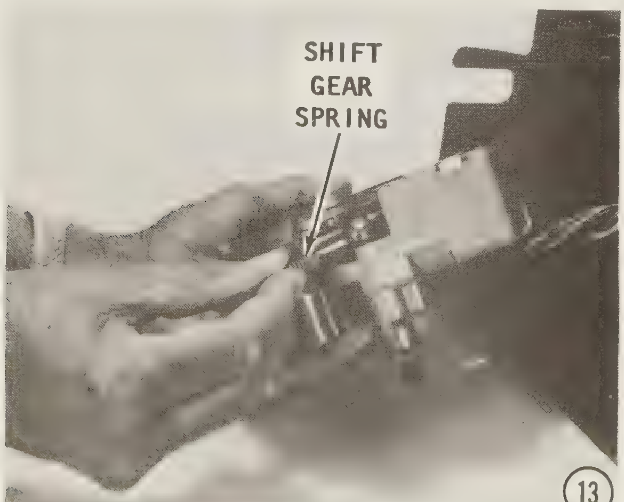
11

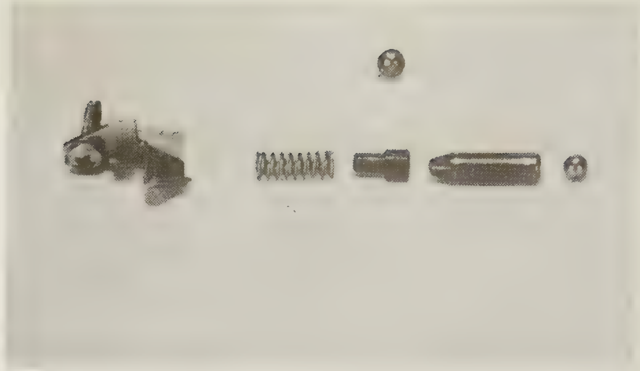
12- Secure the bearing plate assembly to the control module housing with the three Phillips head screws, and then remove the rubber band.

13- Insert the gear shift ball (inner), into the recess of the shift gear and hole in the "throttle only" shaft barrel. Now, insert the shift gear pin into the recess with the rounded end of the pin away from the control shaft. Insert the nylon pin or shift gear ball (outer), into the same recess. Next, insert the shift gear spring.

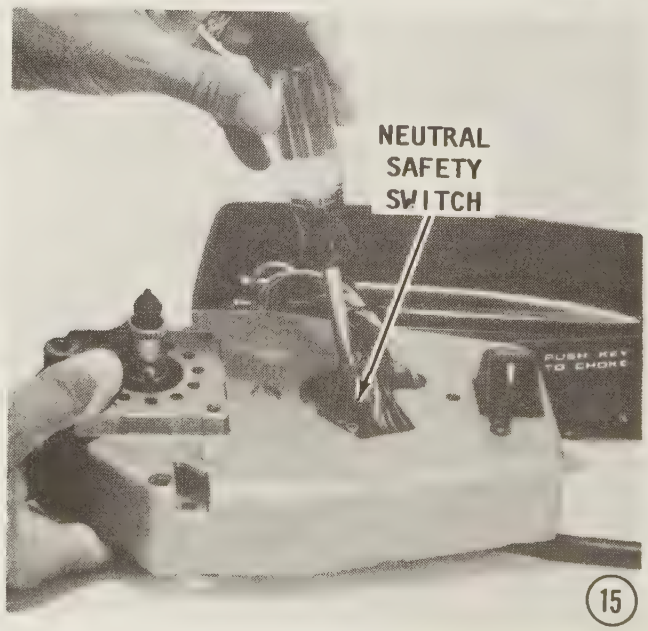
14- Hold these small parts in place and at the same time secure them with the retaining clip and the Phillips head screw. On power trim/tilt units, this retaining clip also secures the trim wire to the control module.

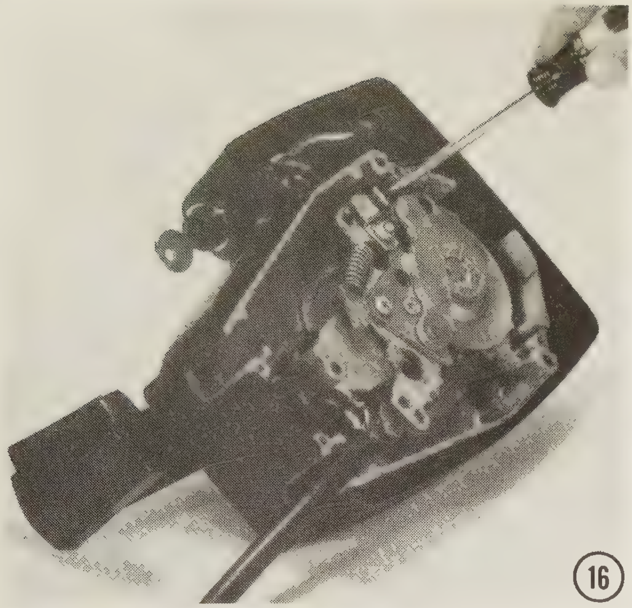
15- Insert the neutral safety microswitch into the recess of the plate assembly and secure it with the two locknuts.





Arrangement of parts, cleaned and ready for installation into the control module recess.





16

16- Secure the control module to the plastic control housing case with the three Phillips head screws. Two are located on either side of the bearing plate and the third in the recess where the throttle cable enters the control housing.

17- Temporarily install the control handle onto the control shaft. Shift the unit into forward detent **ONLY**, not full forward, to align the holes for installation of the throttle link. After the holes are aligned, remove the handle. Install the throttle link.

18- Again, temporarily install the control handle onto the control shaft. This time shift the unit into the **NEUTRAL** position, and then remove the handle. Place the neutral lockring over the control shaft, with the index mark directly beneath the small boot on the front face of the cover.

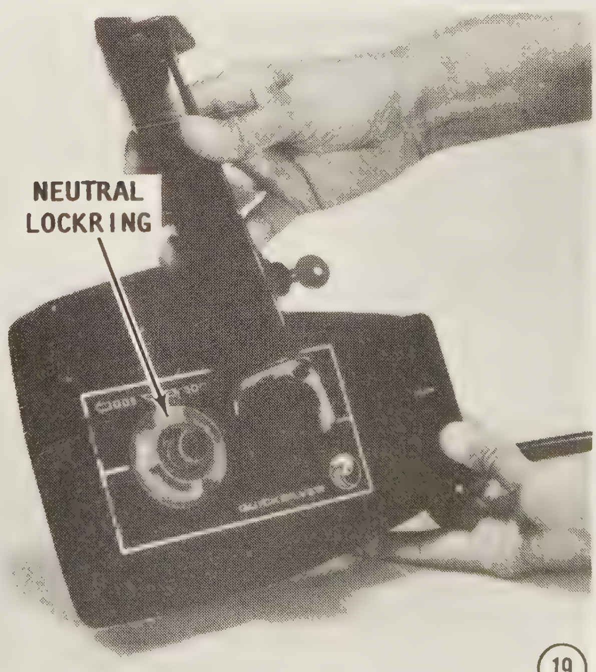
19- Install the control onto the splines of the control shaft. **TAKE CARE** not to cut, pinch, or damage the trim wires on the power trim/tilt unit.

17

CRITICAL WORDS

When positioning the control handle, ensure the trim wire bushing is aligned with its locating pin against the corresponding slot in the control handle. On a Power Trim/Tilt unit only: if this bushing is **NOT** installed correctly, it will not move with the control handle as it is designed to move -- when shifted. This may pinch or cut the trim wires, causing serious problems.

18



19

On a Non-Power Trim/Tilt unit, misplacement of this bushing (it is possible to install this bushing upside down) will not allow the control handle to seat properly against the lockring and housing. This situation will lead to the Allen screw at the base of the control handle to be incorrectly tightened to seat against the splines on the control shaft, instead of gripping the smooth portion of the shaft. Subsequently the control handle will feel "sloppy" and could cause the neutral lock to be ineffective.

WARNING

IF THIS HANDLE IS NOT SEATED PROPERLY, A SLIGHT PRESSURE ON THE HANDLE COULD THROW THE LOWER UNIT INTO GEAR, CAUSING SERIOUS INJURY TO CREW, PASSENGERS, AND THE BOAT.

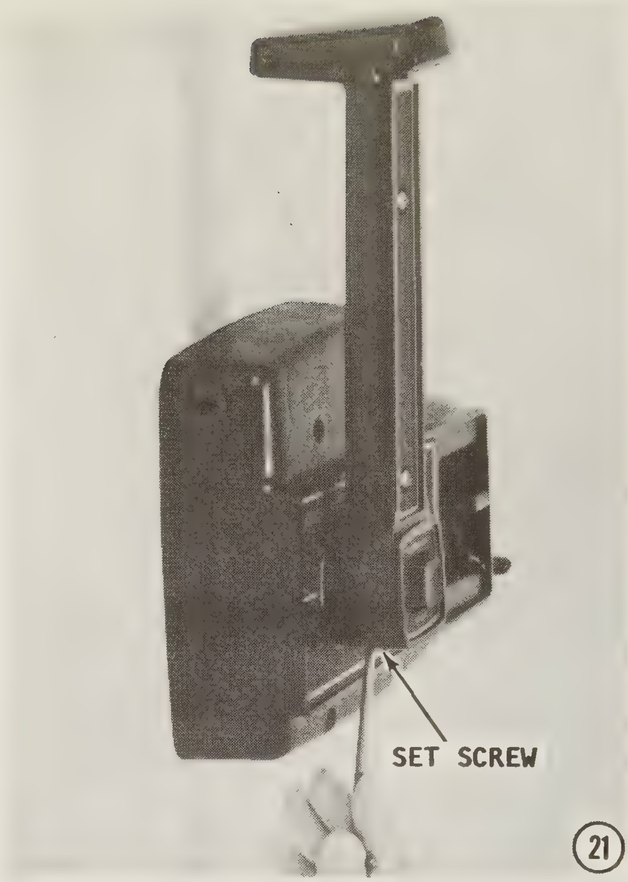
20- Push the "throttle only" button in place on the control shaft.

21- Ensure the control handle has seated properly, and then tighten the set screw at the base of the handle to a torque value of 70 in lbs (7.9Nm).

SAFETY WORDS

FAILURE to tighten the set screw to the required torque value, could allow the handle to disengage with a loss of throttle and shift control. An extremely **DANGEROUS** condition.

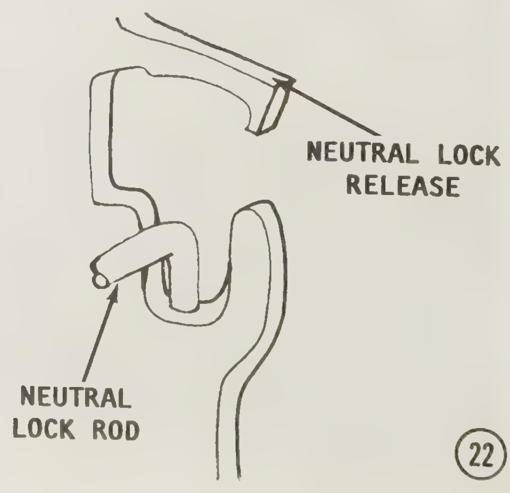
20



21

Power Trim/Tilt Models
or
Non-Power Models
If Handle Cover Was Removed

22- Slide the hooked end of the neutral lock rod into the slot in the neutral lock release. Route the trim wires in the control handle in their original locations. Connect them with the wires remaining in the handle and secure the connections with the wire retainer. Install the handle cover and tighten the two Phillips head screws.



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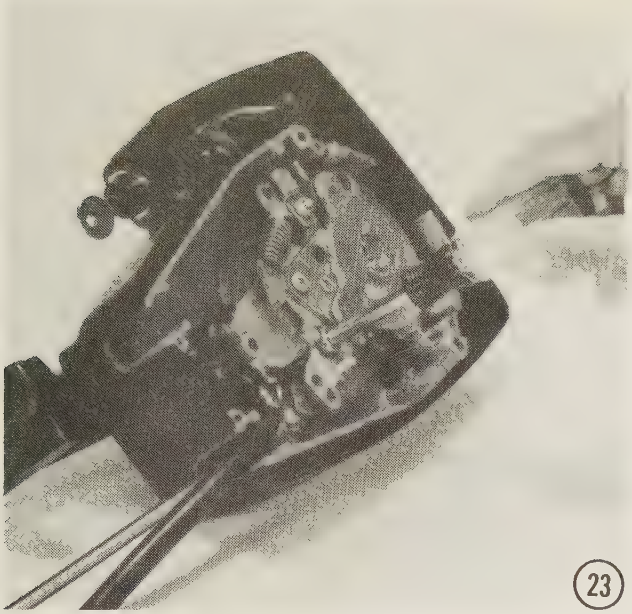
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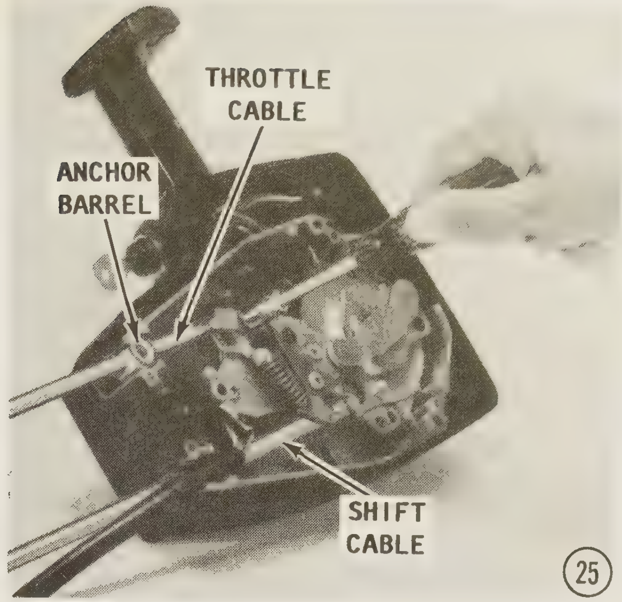


(25)

23- Move the wiring harness clear of the barrel recess. Thread the shift cable anchor barrel to the end of the threads, away from the cable converter, and place it into the recess. Hook the pin on the end of the cable fastener through the outer hole in the shift lever. Depress the **NEUTRAL** lock bar on the control handle and shift the handle into the **REVERSE** position. **TAKE CARE** to ensure the cable fastener will clear the neutral safety micro-switch. The access hole is now aligned with the locknut.

STOP

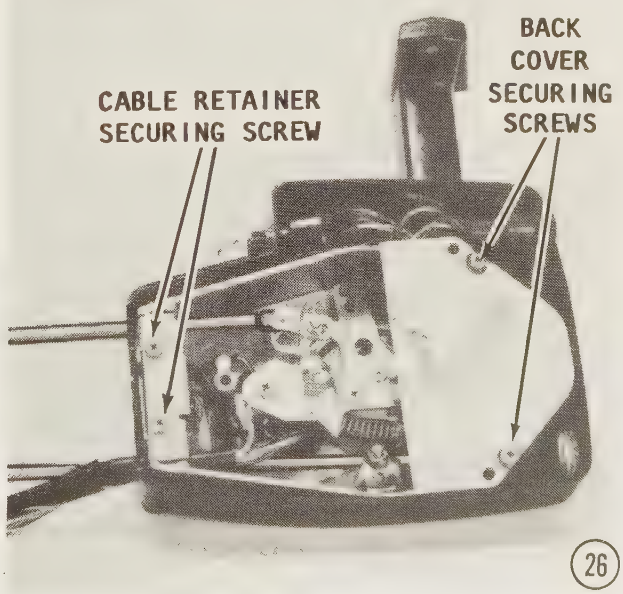
Check to be sure the pin on the cable fastener is all the way through the cable end and the shift lever. A pin partially engaging the cable and the shift lever may cause the cable fastener to **BEND** when the nut is tightened.

Tighten the locknut with a 3/8" deep socket to a torque value of 20 to 25 in. lbs (2.26 to 2.82 Nm). Position the wiring harness over the installed shift cable.

24- Install the grommet into the throttle cable recess.

25- Thread the throttle cable anchor barrel to the end of the threads, away from the cable connector, and then place it into the recess over the grommet. Hook the pin on the end of the cable fastener through the outer hole in the shift lever.

(24)



(26)

STOP AGAIN

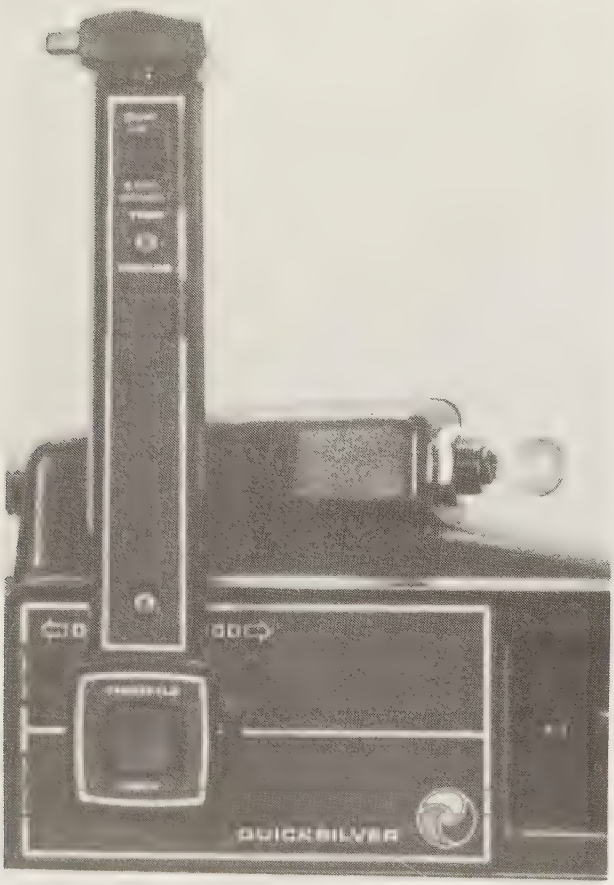
Check to be sure the pin on the cable fastener is all the way through the cable end and the throttle lever. A pin partially engaging the cable and throttle lever may cause the cable fastener to **BEND** when the nut is tightened.

Tighten the locknut to a torque value of 20 to 24 in lbs (2.26 to 2.82Nm).

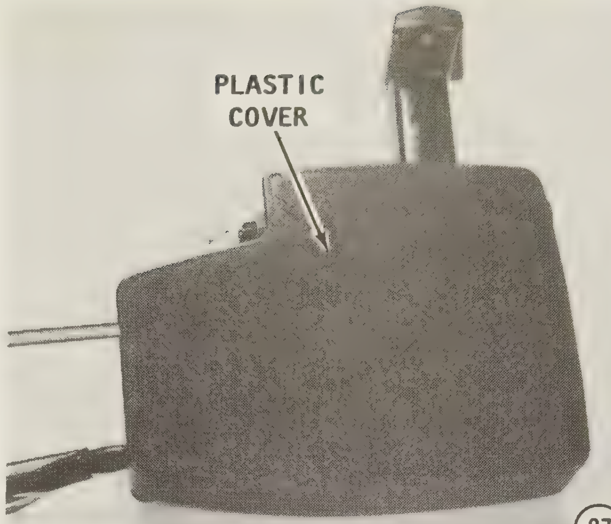
26- Position the control module back cover in place and secure it with the two Phillips head screws. Tighten the screws to a torque value of 60 in lbs (6.78Nm). Install the cable retainer plate over the two cables and secure it in place with the two Phillips head screws.

27- Place the plastic access cover over the control housing.

28- Position the control housing in place on the mounting panel and secure it with the three long (3-1/2") bolts, flat washers, and locknuts. One is located next to the **RUN** button (the ignition safety stop switch). The second is beneath the control handle on the power portion of the plastic case. The third bolt goes in behind the control handle when the handle is in the **NEUTRAL** position.



Commander shift box ready for installation.



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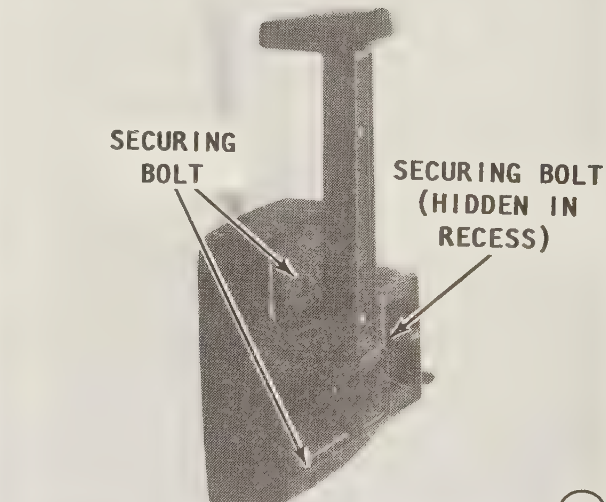

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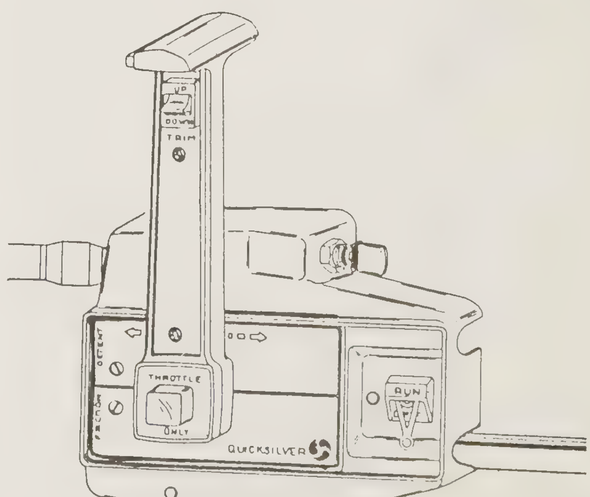

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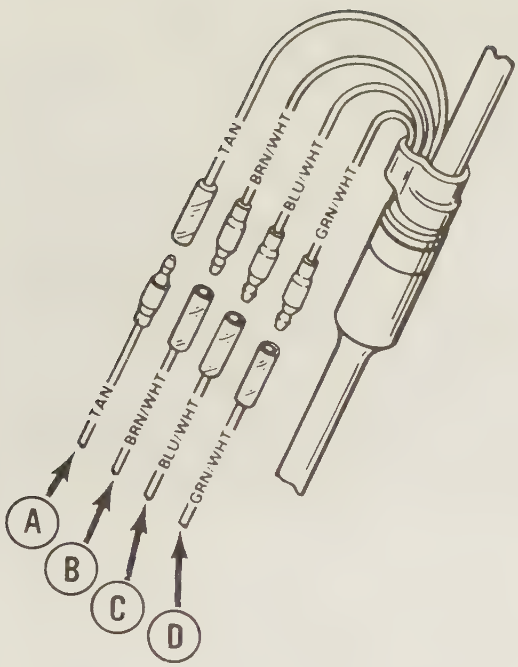
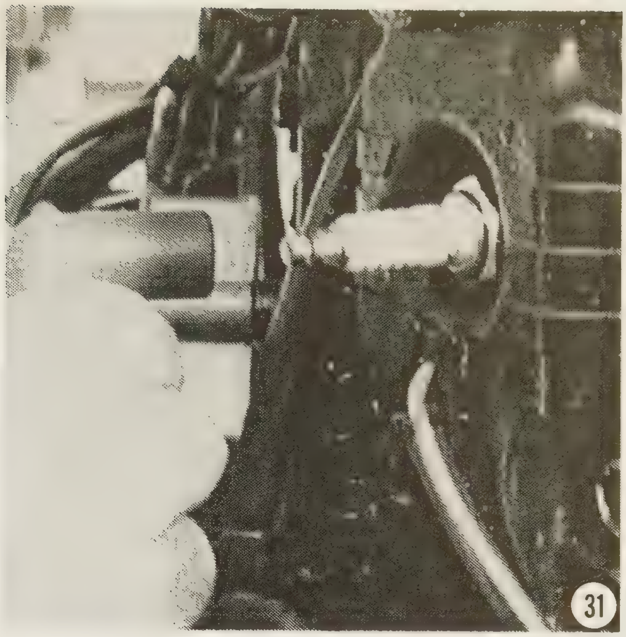


A LEAD FROM TEMP SENDER
B LEAD FROM TRIM SENDER
C LEAD FROM UP SOLENOID
D LEAD FROM DOWN SOLENOID
30


31

Therefore, in order to install this bolt, shift the handle into the **FORWARD** or the **REVERSE** position, and then install the bolt. After the bolt is secure, shift the handle back to the **NEUTRAL** position for the next few steps.

29- Connect the tachometer wiring plug to the forward end of the control housing.

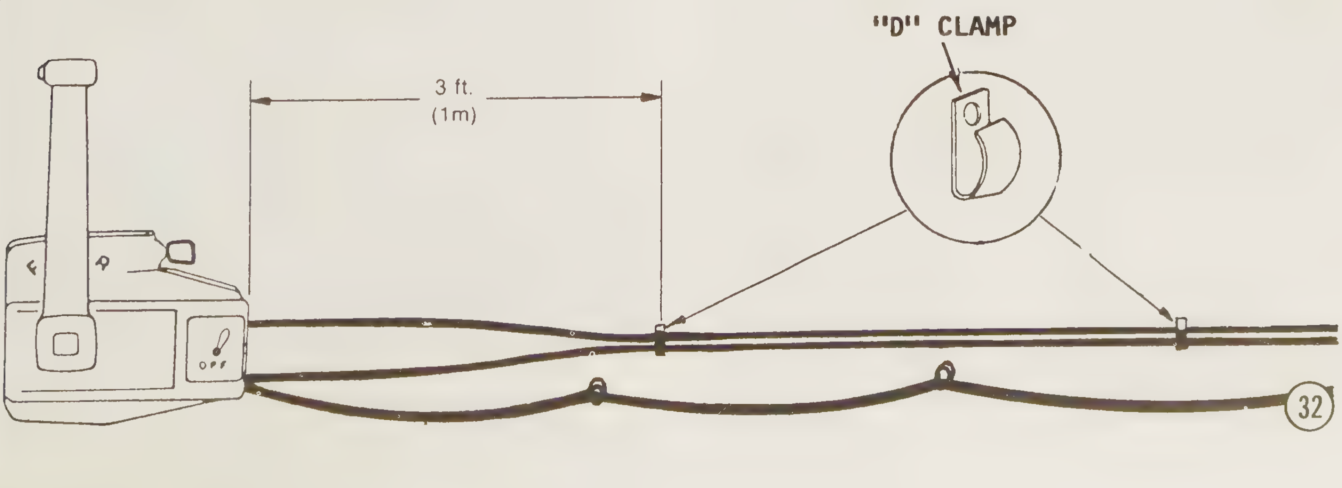
GOOD WORDS

Clean the prongs of the connector with crocus cloth to ensure the best connection possible. Exercise care while cleaning to prevent bending the prongs.

30- Connect the color coded wire leads from the outboard trim/tilt system to the powerhead/remote control wiring harness connectors.

31- Install the high-tension leads to their respective spark plugs.

32- Route the wiring harness alongside the boat and fasten with the "Sta-Straps". Check to be sure the wiring will not be pinched or chafe on any moving part and will not come in contact with water in the bilge. Route the shift and throttle cables the best possible way to make large bends and as few as possible. Secure the cables approximately every three feet (one meter).



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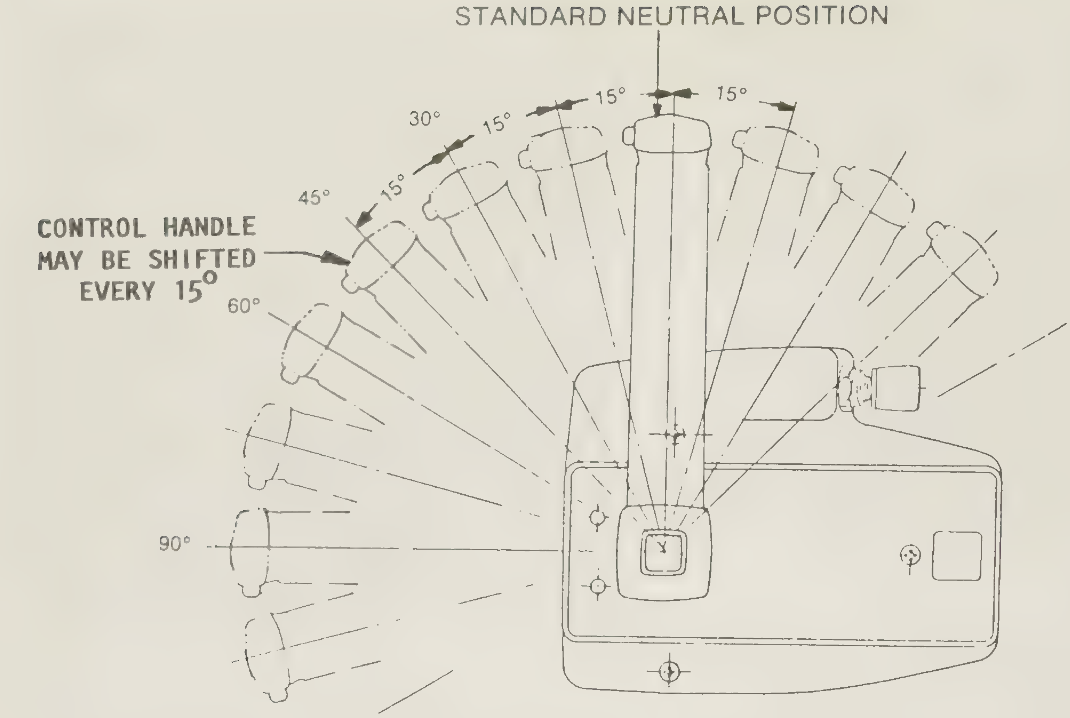


The neutral position of the remote control handle may be changed to any one of a number of convenient angles to meet the owner's preference. The change is accomplished by shifting the handle one spline on the shaft at a time. Each spline equals 15° of arc, as shown.

11-7 CABLE ADJUSTMENTS

Shift Cable Installation and Adjustment

Several engine models are covered in this section. Therefore, the procedural steps are numbered, but the accompanying illustrations have captions instead of step related numbers. As the work progresses, refer to the captions for the particular engine being serviced.

On remote control units equipped with a neutral lock bar, depress the neutral lock bar and secure it in this position with a strong rubber band or a piece of tape. This is necessary to ensure correct location of the true neutral detent while installing the shift and throttle cables to the powerhead. The rubber band will be removed later.

On models equipped with a small neutral warmup lever on the side of the control box, push the lever to the full down position.

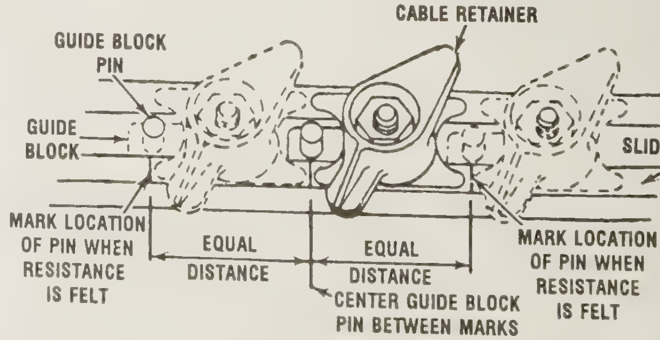
Before starting the adjustments, check to be sure the cable end guide set screws have been tightened to a torque value of 25 in. lbs (2.8 Nm).

1- Disconnect and remove the shift cable, if not previously done. Manually shift the outboard into **NEUTRAL** at the shift lever on the outboard.

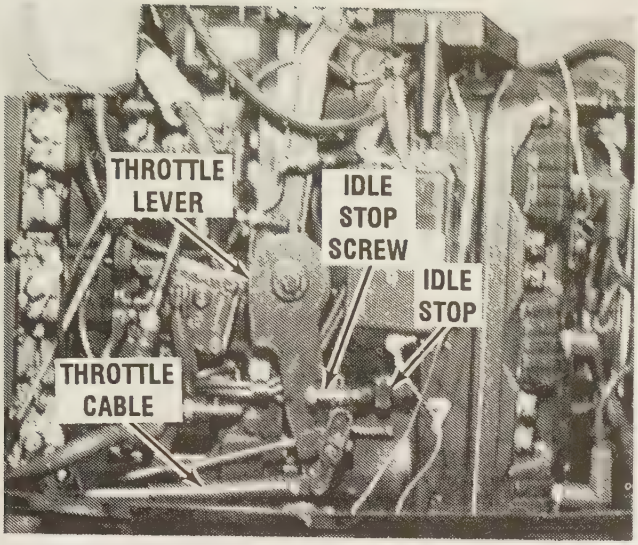
2- Slide the guide block forward until a resistance is felt. Mark the location of the guide pin, as shown in the accompanying illustration. Slide the guide block aft, until resistance is felt once again. Mark the location of the guide pin. Now, slide the guide block forward until the guide pin is centered between the two marks previously made.

3- Position the remote control handle in the **NEUTRAL** position. Feed the shift cable and brass barrel through the rubber grommet in the bottom cowling.

4- Insert the end of the shift cable onto the guide block pin. Center the guide block pin halfway between the two marks made earlier. Rotate the cable retainer over the guide block pin and tighten the nut in the center of the



Line drawing to depict cable adjustment, described in Steps 2, 3, 4, 5 and 6.



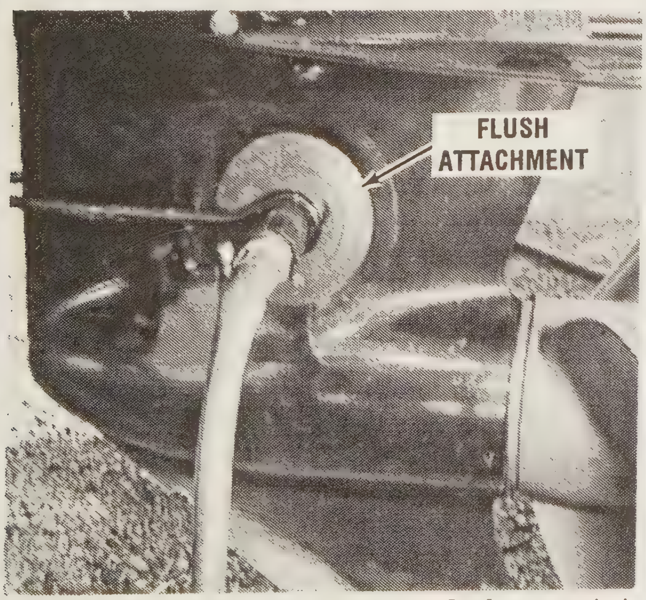
Location of the idle stop and idle speed screw, mentioned in Step 3 for throttle adjustment.

guide block securely.

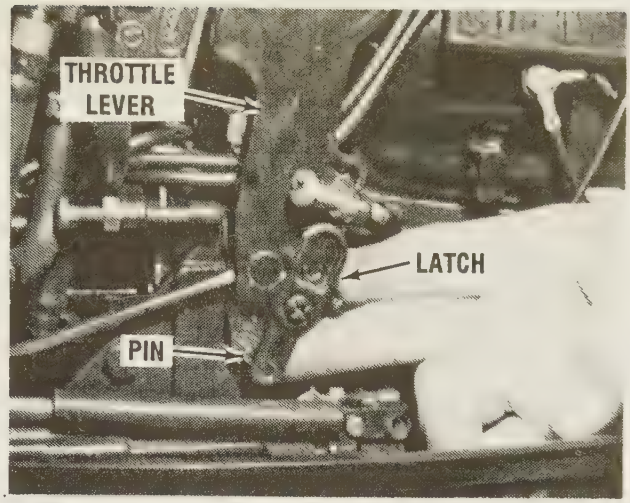
5- On Model 135 thru 225hp, adjust the brass barrel to align and slip into the barrel receptacle **WITHOUT** pre-load.

If servicing an XR4/Magnum II or XR6/Magnum III, adjust the cable barrel so a **SLIGHT PRE-LOAD** in the **REVERSE** gear direction is required for the barrel to slip into the barrel retainer.

6- Move the remote control lever to the **FORWARD** gear position. With the lever in this position, it should not be possible to rotate the propeller counterclockwise. If it is possible to rotate the propeller, adjust the brass barrel **CLOSER** to the cable end guide and repeat Steps 4 thru 6.



Flush attachment connected to the lower unit in preparation to checking the cable adjustment described in the text.



After the throttle cable is installed, be sure to close the latch securing the end of the throttle cable, per Step 4.

7- Shift the remote control lever to the **NEUTRAL** position, without going past the neutral detent. The propeller shaft should now be free to rotate without any drag. Adjust the brass barrel **AWAY** from the cable end guide, if necesaary, and repeat Steps 4 thru 7.

8- Rotate the propeller, and at the same time shift the remote control lever into **REVERSE**. The propeller shaft must not turn clockwise. Adjust the brass barrel **AWAY** from the cable end guide, if necessary, and repeat Steps 4 thru 8.

9- Move the remote control lever to the **NEUTRAL** position without moving past the neutral detent. The propeller should now be free to rotate in either direction without any evidence of drag. Adjust the brass barrel **CLOSER** to the cable end guide, if necessary, and repeat Steps 4 thru 9.

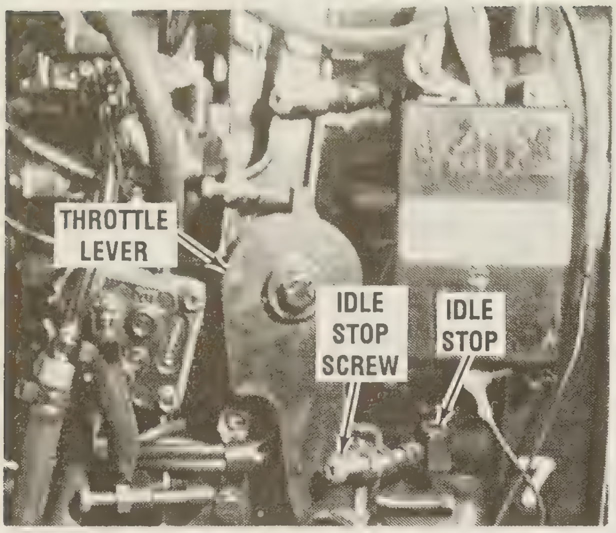
Throttle Cable
Installation and Adjustment

1- Feed the end of the throttle cable through the rubber grommet in the bottom cowling.

2- Place the remote control handle to the **NEUTRAL** position. Move the warmup lever (on the side of standard control only), to the full down position.

CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is operating to prevent damage to the water pump in the lower unit. Just five seconds without water will damage the water pump impeller.



Close view to show where the piece of paper is to be inserted between the idle speed stop screw and the idle stop, as described in the text, in step 5.

3- Connect a flush device on the lower unit and start the powerhead. Adjust powerhead speed, with the lower unit in forward gear, to between 600 and 700 rpm. Refer to the Timing and Synchronizing procedures in Chapter 6 for detailed steps on the particular model outboard being serviced. After idle rpm speed has been set, shutdown the powerhead.

4- Slip the end of the throttle cable over the pin on the throttle lever. Secure the throttle cable in place by closing the latch. While holding the throttle lever against the idle stop, adjust the throttle cable barrel to slip into the barrel receptacle with a very light pre-load of the throttle lever against the idle stop. Secure the throttle and shift cable barrels in place by closing the barrel retainer.

5- Move the remote control handle to open the throttle. Hold a thin sheet of paper between the idle speed stop screw and the idle stop on the powerhead. Continue to hold the paper and close the throttle by moving the remote control handle to the **NEUTRAL** position. The neutral warmup lever **MUST** be in the full down position.

If the paper cannot be removed at this time, the brass barrel is pre-loaded against the idle stop screw.

If the paper can be removed with no drag, the barrel is not close enough to the idle stop screw. Adjust the brass barrel, and repeat the check to be sure it has not been moved too far.

6- Move the remote control to the **FORWARD** gear position and continue to move the handle to the end of its travel -- the wide open throttle position. Check to be sure the throttle plates on the carburetors are at the full throttle position, but not jammed against the stop. See Chapter 6 for detailed timing and synchronizing procedures.

On models so equipped, place the battery lead in the recess. Secure the lead with the retainer and Sta-Strap.

CRITICAL WORDS

Excessive preload on the throttle cable may cause difficult shifting from the **FORWARD** position to the **NEUTRAL** position. If this condition should occur, adjust the throttle cable barrel to reduce the preload.

FUNCTIONAL CHECK

Move the boat to a body of water and make test runs under power. Work the steering system from "hard over" to" hard over" -- port and starboard and check the completed work.

APPENDIX

METRIC CONVERSION CHART

LINEAR

inches	X 25.4	= millimetres (mm)
feet	X 0.3048	= metres (m)
yards	X 0.9144	= metres (m)
miles	X 1.6093	= kilometres (km)
inches	X 2.54	= centimetres (cm)

AREA

inches^2	X 645.16	= millimetres^2 (mm^2)
inches^2	X 6.452	= centimetres^2 (cm^2)
feet^2	X 0.0929	= metres^2 (m^2)
yards^2	X 0.8361	= metres^2 (m^2)
acres	X 0.4047	= hectares (10^4 m^2) (ha)
miles^2	X 2.590	= kilometres^2 (km^2)

VOLUME

inches^3	X 16387	= millimetres^3 (mm^3)
inches^3	X 16.387	= centimetres^3 (cm^3)
inches^3	X 0.01639	= litres (l)
quarts	X 0.94635	= litres (l)
gallons	X 3.7854	= litres (l)
feet^3	X 28.317	= litres (l)
feet^3	X 0.02832	= metres^3 (m^3)
fluid oz	X 29.60	= millilitres (ml)
yards^3	X 0.7646	= metres^3 (m^3)

MASS

ounces (av)	X 28.35	= grams (g)
pounds (av)	X 0.4536	= kilograms (kg)
tons (2000 lb)	X 907.18	= kilograms (kg)
tons (2000 lb)	X 0.90718	= metric tons (t)

FORCE

ounces - f (av)	X 0.278	= newtons (N)
pounds - f (av)	X 4.448	= newtons (N)
kilograms - f	X 9.807	= newtons (N)

ACCELERATION

feet/sec^2	X 0.3048	= metres/sec^2 (m/S^2)
inches/sec^2	X 0.0254	= metres/sec^2 (m/s^2)

ENERGY OR WORK (watt-second - joule - newton-metre)

foot-pounds	X 1.3558	= joules (j)
calories	X 4.187	= joules (j)
Btu	X 1055	= joules (j)
watt-hours	X 3500	= joules (j)
kilowatt - hrs	X 3.600	= megajoules (MJ)

FUEL ECONOMY AND FUEL CONSUMPTION

miles/gal	X 0.42514	= kilometres/litre (km/l)

Note:
235.2/(mi/gal) = litres/100km
235.2/(litres/100 km) = mi/gal

LIGHT

footcandles	X 10.76	= lumens/metre^2 (lm/m^2)

PRESSURE OR STRESS (newton/sq metre - pascal)

inches HG (60° F)	X 3.377	= kilopascals (kPa)
pounds/sq in	X 6.895	= kilopascals (kPa)
inches H_2O (60° F)	X 0.2488	= kilopascals (kPa)
bars	X 100	= kilopascals (kPa)
pounds/sq ft	X 47.88	= pascals (Pa)

POWER

horsepower	X 0.746	= kilowatts (kW)
ft-lbf/min	X 0.0226	= watts (W)

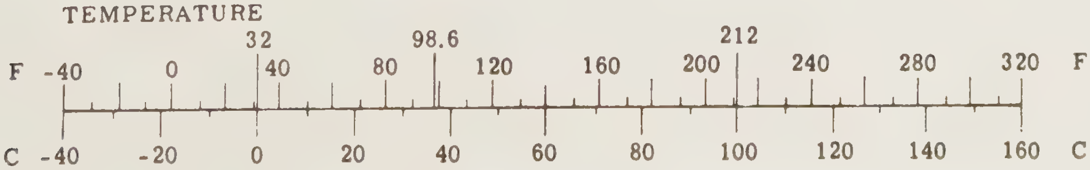
TORQUE

pound-inches	X 0.11299	= newton-metres (N·m)
pound-feet	X 1.3558	= newton-metres (N·m)

VELOCITY

miles/hour	X 1.6093	= kilometres/hour (km/h)
feet/sec	X 0.3048	= metres/sec (m/s)
kilometres/hr	X 0.27778	= metres/sec (m/s)
miles/hour	X 0.4470	= metres/sec (m/s)

TEMPERATURE



Celsius = 0.556 (°F -32) F = (1.8°C) +32

POWERHEAD SPECIFICATIONS

MODEL	CU. IN. DISPL.	CU. CM. DISPL.	BORE INCHES	STROKE INCHES	SPARK PLUG CHAMP.	SPARK PLUG NGK
1990	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**
135	122	1999	3.125 (79.375 mm)	2.650 (67.31 mm)	L6VC	BU8H
150	122	1999	3.125 (79.375 mm)	2.650 (67.31 mm)	L6VC	BU8H
XR4 MAGNUM II	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
175	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
200	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
200XRi	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BUZ8 H-N-10
175 Ski	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
275	207	3393	3.74 (94.996 mm)	3.14 (79.756 mm)	L6VC	BU8H
1991	**1991**	**1991**	**1991**	**1991**	**1991**	**1991**
135/150	122	1999	3.125 (79.375 mm)	2.650 (67.31 mm)	L6VC	BU8H
175	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
XR4/MAGNUM II NOTE 1	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
XR4/MAGNUM II NOTE 2	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
200 NOTE 3	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200 NOTE 4	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
175 Ski	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
175 XRi NOTE 5	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H
175 XRi NOTE 6	142	2327	3.375 (85.725 mm)	2.650 (67.31 mm)	L6VC	BU8H

AND TUNE-UP ADJUSTMENTS

SPARK PLUG GAP	CARB. TYPE	MAX TIMING @ CRANKING SPEED	MAX TIMING @ WIDE OPEN THROTTLE	PICKUP TIMING	IDLE TIMING	IDLE RPM (In Forward Gear)	FULL THROTTLE RPM
1990	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**
SURFACE GAP	A	18° BTDC	16° BTDC	5°- 7° ATDC	3°- 11° ATDC	600 - 700	5000 - 5500
SURFACE GAP	A	18° BTDC	16° BTDC	6°- 12° ATDC	6°- 12° ATDC	600 - 700	5000 - 5500
SURFACE GAP	A	22° BTDC	25° BTDC	4°- 6° ATDC	3°- 11° ATDC	625- 700	5000 - 5500
SURFACE GAP	A	20° BTDC	18° BTDC	3°- 5° ATDC	3°- 11° ATDC	600 - 700	5300 - 5800
SURFACE GAP	A	22° BTDC	26° BTDC	2°- 7° ATDC	2°- 7° ATDC	600 - 700	5300 - 5800
0.040	F.I.	19° BTDC	N/A	N/A	9° ATDC	600 - 675	5400 - 5900
SURFACE GAP	F.I.	22° BTDC	N/A	N/A	10° ATDC	600 - 675	5200 - 5700
SURFACE GAP	C	22° BTDC	20° BTDC	5° ATDC	5° ATDC	600 - 675	5000 - 5500
1991	**1991**	**1991**	**1991**	**1991**	**1991**	**1991**	**1991**
SURFACE GAP	B	19° BTDC NOTE 7	17° BTDC	2°- 9° ATDC	2°- 9° ATDC	600 - 700	5000 - 5600
SURFACE GAP	B	22° BTDC NOTE 7	20° BTDC	2°- 9° ATDC	2°- 9° ATDC	625 - 700	5000 - 5600
SURFACE GAP	B	19° BTDC	26° BTDC	2°- 9° ATDC	2°- 9° ATDC	625 - 700	5000 - 5600
SURFACE GAP	B	19° BTDC	20° BTDC	2°- 9° ATDC	2°- 9° ATDC	625 - 700	5000 - 5600
SURFACE GAP	B	22° BTDC NOTE 7	20° BTDC	2°- 9° ATDC	2°- 9° ATDC	625 - 700	5000 - 5600
SURFACE GAP	B	21° BTDC NOTE 7	25° BTDC	2°- 9° ATDC	2°- 9° ATDC	625 - 700	5000 - 5600
SURFACE GAP	F.I.	22° BTDC NOTE 7	22° BTDC	N/A	4° BTDC	600 - 675	5200 - 5700
SURFACE GAP	F.I.	23° BTDC NOTE 7	23° BTDC	N/A	4° BTDC	600 - 675	5000 - 5600
SURFACE GAP	F.I.	21° BTDC NOTE 7	25° BTDC	N/A	4° BTDC	600 - 675	5000 - 5600

POWERHEAD SPECIFICATIONS

MODEL	CU. IN. DISPL.	CU. CM. DISPL.	BORE INCHES	STROKE INCHES	SPARK PLUG CHAMP.	SPARK PLUG NGK
1991	**1991**	**1991**	**1991**	**1991**	**1991**	**1991**
200 XRi	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
275	207	3393	3.74 (94.996 mm)	3.14 (79.756 mm)	L6VC	BU8H
1992	**1992**	**1992**	**1992**	**1992**	**1992**	**1992**
135/150	122	1999	3.125 (79.375 mm)	2.650 (67.31 mm)	L6VC	BU8H
175	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
XR6/MAGNUM III	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200 with Spark Advance Module	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200 with Idle Stabilization Module	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
150/175 EFI	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200 EFI	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
275	207	3393	3.74 (94.996 mm)	3.14 (79.756 mm)	L6VC	BU8H
1993	**1993**	**1993**	**1993**	**1993**	**1993**	**1993**
135/150	122	1999	3.125 (79.375 mm)	2.650 (67.31 mm)	L6VC	BU8H
175	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
XR6/Magnum III	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H

AND TUNE-UP ADJUSTMENTS

SPARK PLUG GAP	CARB. TYPE	MAX TIMING @ CRANKING SPEED	MAX TIMING @ WIDE OPEN THROTTLE	PICKUP TIMING	IDLE TIMING	IDLE RPM (In Forward Gear)	FULL THROTTLE RPM
1991	**1991**	**1991**	**1991**	**1991**	**1991**	**1991**	**1991**
SURFACE GAP	F.I.	19° BTDC NOTE 7	25° BTDC	N/A	4° BTDC	600 - 675	5000 - 5800
SURFACE GAP	C	22° BTDC	20° BTDC	5° ATDC	5° ATDC	600 - 675	5000 - 5500
1992	**1992**	**1992**	**1992**	**1992**	**1992**	**1992**	**1992**
SURFACE GAP	B	22° BTDC NOTE 8	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	19° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	19° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	21° BTDC NOTE 8	25° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	22° BTDC NOTE 8	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	F.I	19° BTDC NOTE 8	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	600 - 700	5000 - 5600
SURFACE GAP	F.I.	20° BTDC	26° BTDC	0°- 9° ATDC	0°- 9° ATDC	600 - 700	5000 - 5800
SURFACE GAP	C	22° BTDC	20° BTDC	5° ATDC	5° ATDC	650 - 700	5000 - 5500
1993	**1993**	**1993**	**1993**	**1993**	**1993**	**1993**	**1993**
SURFACE GAP	B	22° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	19° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	19° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	22° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600

POWERHEAD SPECIFICATIONS

MODEL	CU. IN. DISPL.	CU. CM. DISPL.	BORE INCHES	STROKE INCHES	SPARK PLUG CHAMP.	SPARK PLUG NGK
1993	**1993**	**1993**	**1993**	**1993**	**1993**	**1993**
150/175 XRi	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200 XRi	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
275	207	3393	3.74 (94.996 mm)	3.14 (79.756 mm)	L6VC	BU8H
1994 and On	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**
135/150	122	1999	3.125 (79.375 mm)	2.650 (67.31 mm)	L6VC	BU8H
150XR6/Magnum III/175	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
150 XRi/175 XRi	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
200XRi	153	2507	3.500 (88.9 mm)	2.650 (67.31 mm)	L6VC	BU8H
225 ECU	185	3044	3.625 (92.075 mm)	3.00 (76.2 mm)	N/A	BUZ8 H-N-10
275	207	3393	3.74 (94.996 mm)	3.14 (79.756 mm)	L6VC	BU8H

AND TUNE-UP ADJUSTMENTS

SPARK PLUG GAP	CARB. TYPE	MAX TIMING @ CRANKING SPEED	MAX TIMING @ WIDE OPEN THROTTLE	PICKUP TIMING	IDLE TIMING	IDLE RPM (In Forward Gear)	FULL THROTTLE RPM
1993	**1993**	**1993**	**1993**	**1993**	**1993**	**1993**	**1993**
SURFACE GAP	F.I.	19° BTDC	20° BTDC	4° ATDC	4° ATDC	600 - 700	5000 - 5600
SURFACE GAP	F.I.	20° BTDC	26° BTDC	4° ATDC	4° ATDC	600 - 700	5000 - 5800
SURFACE GAP	C	22° BTDC	20° BTDC	5° ATDC	5° ATDC	650 - 700	5000 - 5500
1994 and On	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**	**1994 and On**
SURFACE GAP	B	22° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	B	19° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	F.I.	19° BTDC	20° BTDC	4° ATDC	4° ATDC	600 - 700	5000 - 5600
SURFACE GAP	B	22° BTDC	20° BTDC	0°- 9° ATDC	0°- 9° ATDC	625 - 725	5000 - 5600
SURFACE GAP	F.I.	20° BTDC	26° BTDC	4° ATDC	4° ATDC	600 - 700	5000 - 5800
0.040	B	N/A	22° BTDC	4°- 8° ATDC	4°- 8° ATDC	600 - 700	5000 - 5500
SURFACE GAP	C	22° BTDC	20° BTDC	5° ATDC	5° ATDC	650 - 725	5000 - 5500

POWERHEAD SPECIFICATIONS AND TUNE-UP ADJUSTMENTS

NOTE 1. XR4/MAGNUM II models serial numbers OC247591 thru OC254931 equipped with Idle Stabilizer/Advance Module.

2. XR4/MAGNUM II models serial numbers OC254932 and up equipped with Idle Stabilizer Module only.

3. Model 200 serial numbers OC291520 thru OC077247 equipped only with an Idle Stabilizer Module.

4. Model 200 serial numbers OC077248 and up equipped only with Idle Stabilizer/Advance Module.

5. Model 175 XRi serial numbers C221500 thru OD0071413.

6. Model 175 XRi serial numbers OD0071414 and up.

7. Models equipped with Idle Stabilizer Shift Kit (P/N 87-814281A1) as an accessory, excluding XR4/MAGNUM II models, require **Maximum Timing @ Cranking Speed** be retarded **3°** from the timing specification listed in the Powerhead Specifications and Tune Up Adjustments chart. The XR4/MAGNUM II models with factory installed Idle Stabilizer Shift Kit has this timing adjustment calibrated into the specifications.

8. Models equipped with Idle Stabilizer Shift Kit (P/N 87-814281A1) as an accessory, excluding XR6/MAGNUM III and 175 models, require **Maximum Timing @ Cranking Speed** be retarded **3°** from the timing specification listed in the Powerhead Specifications and Tune Up Adjustments chart. The XR6/MAGNUM III and 175 models with factory installed Idle Stabilizer Shift Kit has this timing adjustment calibrated into the specifications.

1990 ALTITUDE JET CHARTS
MODEL 135HP, XR4/MAGNUM II, 150, 175 & 200HP
WITH WALBRO WH CARBURETOR

HIGH ALTITUDE JET CHART		
Engine Operating Elevation (Above Sea Level)	**Jet**	**Install jet with an orifice:**
2500′ - 5000′ (762 - 1524m)	Main Vent* Idle	.002″ smaller (than standard jet) .002″ smaller (than standard jet) .002″ larger (than standard jet)
5000′ - 7500′ (1524 - 2286m)	Main Vent* Idle	.004″ smaller (than standard jet) .004″ smaller (than standard jet) .004″ larger (than standard jet)
7500′ and Up (2286m and Up)	Main Vent* Idle	.006″ smaller (than standard jet) .006″ smaller (than standard jet) .006″ larger (than standard jet)

*If standard vent jet is listed as none, then DO NOT install a jet.

	CARBURETOR NO. (STAMPED ON TOP OF CARBURETOR MOUNTING FLANGE)		STANDARD JET CHART NOTE: Jets listed are for engine operation from 0-2500 feet (0-762m) of elevation.																	
			MAIN JET						IDLE JET						VENT JET					
			CYL 1	CYL 2	CYL 3	CYL 4	CYL 5	CYL 6	CYL 1	CYL 2	CYL 3	CYL 4	CYL 5	CYL 6	CYL 1	CYL 2	CYL 3	CYL 4	CYL 5	CYL 6
175	TOP	WH34-1	.064	066					070	.070					NONE	NONE				
	CENTER	WH34-2			.064	.064					070	.070					NONE	NONE		
	BOTTOM	WH34-3					066	064					.070	.070					NONE	NONE
(Mariner) 135	TOP	WH35-1	050	.050					.060	.060					.094	094				
	CENTER	WH35-2			.050	050					060	060					094	094		
	BOTTOM	WH35-3					050	050					060	060					094	094
(Merc) 135	TOP	WH38-1	052*	052*					046•	046•					096	096				
	CENTER	WH38-2			.052*	.052*					046•	046•					096	096		
	BOTTOM	WH38-3					052*	.052*					046•	.046•					096	096
(1988) 150	TOP	WH40-1	.080	080					048	048					078	078				
	CENTER	WH40-2			.080	.080					048	048					078	078		
	BOTTOM	WH40-3					080	080					048	048					078	078
(1989) 150	TOP	WH48-1	080	080					044	044					078	078				
	CENTER	WH48-2			.080	080					044	044					078	078		
	BOTTOM	WH48-3					.080	080					044	044					078	078
Mag II/ XR-4	TOP	WH41-1	.074	.074					.052	.052					.076	.076				
	CENTER	WH41-2			.074	.074					052	052					076	076		
	BOTTOM	WH41-3					074	074					052	.052					076	076
Mag II/ XR-4	TOP	WH41-1A	074	074					048	048					076	076				
	CENTER	WH41-2A			074	074					048	048					076	076		
	BOTTOM	WH41-3A					.074	074					048	048					076	076
200	TOP	WH46-1	.080	.082					.056	.056					.096	NONE				
	CENTER	WH46-2			080	.080					056	056					096	096		
	BOTTOM	WH46-3					082	080					.056	056					NONE	096
200	TOP	WH49-1	080	082					054	054					096	NONE				
	CENTER	WH49-2			080	080					054	054					096	096		
	BOTTOM	WH49-3					082	080					054	054					NONE	096

* .056 S/N OC212890 and above

● .044 on some models

1991 ALTITUDE JET CHARTS
MODEL 135, XR4/MAGNUM II, 150, 175 & 200HP
WITH WALBRO WMH CARBURETOR

STANDARD JET CHART

NOTE: Jets listed are for outboard operation from 0-5000 feet (0-1524m) of elevation.

Outboard Model	Carburetor Identification No. (WMH)	Main Jet	Off-Idle "Progression" Air Jet	Idle Air Bleed Jet	Back Draft Vent Jet
135	"5-___"	.050	.036	.048	070
	"8-___"	.050	.040	.048	None
	"8-___A"	.050	.040	.048	None
150	"1-___"	.062	.044	.048*	.084
	"7-___"	.062	.034	.040	None
XR4/ Magnum II	"4-___"	.062	.030	044	None
	"4-___A"	.062	.030	040	None
	"6-___A"	.062	.030	040	None
	"10-___"	.062	.040	.040	None
175	"2-___"	.064	.044	.052	.080
	"2-___A"	.064	.044	.044	.080
	"11-___"	.064	.070	.048	.080
	"11-___A"	.064	.070	.048	.080
200	"3-___B"	.066	.034	.040	082
	"3-___C"	066	.034	040	082

*NOTE: Some WMH "1-___" (150 Model) carburetors may have .040 idle air bleed jets installed at factory.

High Altitude Jet Chart 150 and 175

Engine Operating Elevation (Above Sea Level)	Jet/fuel Mixture Screw	Install Jet With An Orifice/ Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	.006" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.004" Smaller (Than Standard)
	Progression	.006" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m and Up)	Main	.004" Smaller (Than Standard)
	Progression	.006" Larger (Than Standard)
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart 135 and XR4/Mag II

Engine Operating Elevation (Above Sea Level)	Jet/fuel Mixture Screw	Install Jet With An Orifice/ Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	.004" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.004" Smaller (Than Standard)
	Progression	.004" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m and Up)	Main	.004" Smaller (Than Standard)
	Progression	.004" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation

High Altitude Jet Chart 200

Engine Operating Elevation (Above Sea Level)	Jet/fuel Mixture Screw	Install Jet With An Orifice/ Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	.002" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.006" Smaller (Than Standard)
	Progression	.004" Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m and Up)	Main	.006" Smaller (Than Standard)
	Progression	.004" Larger (Than Standard)
	Fuel Mixture Screw	60° Clockwise Rotation

1992 -- 1993 ALTITUDE JET CHARTS
MODEL 135, WR6, MAGNUM III, 150, 175 & 200HP
WITH WALBRO WMH CARBURETOR

Standard Jet Chart

Note: Jets listed are for engine operation from 0-5000 feet (0-1524m) of elevation.

Outboard Model	Carburetor Identification Number	Main Jet	Off-Idle "Progression" Air Jet	Idle Air Bleed Jet	Back Draft Vent Jet
135	WMH "12 -__"	.064	.070	.052	.060
	WMH "12 -__B"	.060	.050	.056	.090
	WMH "24 -__"	.060	.050	.056	.090
	WMH "28 -__B"	.062	.050	.056	NONE
150	WMH "13-__"	.064	.070	.050	.096
	WMH "13-__B"	.064	.048	.050	.096
	WMH "23-__"	.060	.050	.054	.094
XR6/Mag III	WMH "14-__"	.054	.050	.052	.086
	WMH "25-__"	.060	.050	.050	.086
175	WMH "15-__"	.064	.070	.054	.080
	WMH "22-__"	.064	.040	.052	.098
	WMH "22-__A"	.064	.040	.050	.098
200	WMH "16-__"	.066	.050	.058	.090
	WMH "21-__"	.064	.050	.046	.096

High Altitude Jet Chart 135

Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	.006 in. Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.004 in. Smaller (Than Standard)
	Progression	.006 in. Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.006 in. Smaller (Than Standard)
	Progression	.006 in. Larger (Than Standard)
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart 150/175

Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	.006 in. Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.004 in. Smaller (Than Standard)
	Progression	.006 in. Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.006 in. Smaller (Than Standard)
	Progression	.006 in. Larger (Than Standard)
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart XR6/Mag III

Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	Standard Jet
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.004 in. Smaller (Than Standard)
	Progression	.002 in. Larger (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.006 in. Smaller (Than Standard)
	Progression	.002 in. Larger (Than Standard)
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart 200

Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	Standard Jet
	Progression	.004 in. Smaller (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.006 in. Smaller (Than Standard)
	Progression	.004 in. Smaller (Than Standard)
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.006 in. Smaller (Than Standard)
	Progression	.004 in. Smaller (Than Standard)
	Fuel Mixture Screw	60° Clockwise Rotation

1994 & ON ALTITUDE JET CHARTS
MODEL 135, 150, XR6, MAGNUM III, 175, 200 & 225HP
WITH WALBRO WMH CARBURETOR

Standard Jet Chart Note: Jets listed are for engine operation from 0-5000 feet (0-1524m) of elevation.					
Outboard Model	Carburetor Identification Number	Main Jet	Off-Idle "Progression" Air Jet	Idle Air Bleed Jet	Back Draft Vent Jet
135	WMH 30-__	.066	.050	.054	.084
150	WMH 31-__	.062	.050	.052	.086
XR6/MAG III	WMH 32-__	.062	.040	.058	.090
175	WMH 33-__	.064	.050	.048	.084
200	WMH 34-__	1,2 – .066 3,4,5,6 – .064	.050	.046	.084

High Altitude Jet Chart 135		
Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	.064
	Progression	.052
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.062
	Progression	.052
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.060
	Progression	.052
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart 175		
Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	.062
	Progression	.052
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.060
	Progression	.052
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.058
	Progression	.052
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart 150/XR6/Mag III		
Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	.060
	Progression	150 – .052 XR6/MAGIII – .042
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	.058
	Progression	150 – .052 XR6/MAGIII – .042
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	.056
	Progression	150 – .052 XR6/MAGIII – .042
	Fuel Mixture Screw	60° Clockwise Rotation

High Altitude Jet Chart 200		
Outboard Operating Elevation (Above Sea Level)	Jet/Fuel Mixture Screw	Jet Size: Adjust Fuel Mixture Screw:
5000 ft. - 7500 ft. (1524m - 2286m)	Main	#1,2 – .064 #3,4,5,6 – .062
	Progression	.052
	Fuel Mixture Screw	30° Clockwise Rotation
7500 ft. - 10000 ft. (2286m - 3048m)	Main	#1,2 – .062 #3,4,5,6 – .060
	Progression	.052
	Fuel Mixture Screw	30° Clockwise Rotation
10000 ft. and Up (3048m - and Up	Main	#1,2 – .060 #3,4,5,6 – .058
	Progression	.052
	Fuel Mixture Screw	60° Clockwise Rotation

1990 & ON ALTITUDE JET CHARTS
MODEL 275HP
WITH WALBRO WO CARBURETOR

CARBURETOR JET SIZES

Jet	TOP WO-9-1/ WO-9-2		CENTER WO-9-3/ WO-9-4		BOTTOM WO-9-5/ WO-9-6	
	CYL. 1	CYL. 2	CYL. 3	CYL. 4	CYL. 5	CYL. 6
Main Jet	.082	.082	.084	.082	.088	.082
Idle Jet	.060	.060	.060	.060	.060	.060
Vent Jet	None	None	None	None	None	None

HIGH ALTITUDE JET CHARTS

Engine Operating Elevation (Above Sea Level)	Jet	Jet Size
762 m - 1524 m (2500 ft. - 5000 ft.)	Main Vent* Idle	.002 in. smaller (than standard jet) .002 in. smaller (than standard jet) .002 in. smaller (than standard jet)
1524 m - 2286 m (5000 ft. - 7500 ft.)	Main Vent* Idle	.004 in. smaller (than standard jet) .004 in. smaller (than standard jet) .004 in. smaller (than standard jet)
2286 m and up (7500 ft. and up)	Main Vent* Idle	.006 in. smaller (than standard jet) .006 in. smaller (than standard jet) .006 in. smaller (than standard jet)

* If Standard vent jet is listed as none, then DO NOT install a jet

LUBRICATION CAPACITY AND GEAR RATIO

MODEL/ H.P.	CYLS.	YEAR	OIL CAP. OUNCES	NO. TEETH FORWARD	NO. TEETH PINION	GEAR RATIO
135	V-6	1990 & On	22.5oz. (652 ml)	28	14	2.00:1
150	V-6	1990 & On	22.5oz. (652 ml)	28	14	2.00:1
150 XR4	V-6	1990 1991	22.5oz. (652 ml)	25	14	1.78:1
150 XR6	V-6	1992 & On	22.5oz. (652 ml)	28	15	1.87:1
150 XRi	V-6	1993 & On	22.5oz. (652 ml)	28	15	1.87:1
175	V-6	1990 1991	22.5oz. (652 ml)	28	15	1.87:1
175	V-6	1992 & On	22.5oz. (652 ml)	28	14	2.00:1
175 XRi	V-6	1990 1991	22.5oz. (652 ml)	28	15	1.87:1
175 XRi - SKI	V-6	1992 & On	22.5oz. (652 ml)	28	15	1.87:1
200	V-6	1990 & On	22.5oz. (652 ml)	28	15	1.87:1
200 XRi	V-6	1990 & On	22.5oz. (652 ml)	28	15	1.87:1
225	V-6	1994 & On	28.0oz. (812.0 ml)	28	17	1.64:1
275	V-6	1990 & On	29.0oz. (841 ml)	28	17	1.64:1

PISTON CYLINDER SPECIFICATIONS

MODEL/ H.P.	YEAR	CYLS.	PISTON SIZE		BLOCK MAX. TAPER		STANDARD CYL. BLOCK HONE FINISH		.015 OVERSIZE HONE FINISH		.030 OVERSIZE HONE FINISH	
			INCHES	mm	INCHES	mm	INCHES	mm	INCHES	mm	INCHES	mm
135	1990 & On	V-6	3.115	79.121	0.006	0.152	3.125	79.375	3.140	79.756	3.155	80.137
150	1990 & On	V-6	3.115	79.121	0.006	0.152	3.125	79.375	3.140	79.756	3.155	80.137
150 XR4	1990 1991	V-6	3.371	85.623	0.006	0.152	3.377	85.776	3.392	86.157	--	--
150 XR6	1992 & On	V-6	3.494	88.745	0.006	0.152	3.501	88.925	3.516	89.306	--	--
150 XRi	1993 & On	V-6	3.494	88.745	0.006	0.152	3.501	88.925	3.516	89.306	--	--
175	1990 1991	V-6	3.371	85.623	0.006	0.152	3.377	85.776	3.392 Note 1	86.157 Note 1	--	--
175	1992 & On	V-6	3.494	88.745	0.006	0.152	3.501	88.925	3.516	89.306	--	--
175 XRi	1990 1991	V-6	3.371	85.623	0.006	0.152	3.377	85.776	3.392 Note 1	86.157 Note 1	--	--
175 XRi - SKI	1992 & On	V-6	3.494	88.745	0.006	0.152	3.501	88.925	3.516	89.306 Note 1	--	--
200	1990 & On	V-6	3.494	88.745	0.006	0.152	3.501	88.925	3.516 Note 1	89.306 Note 1	--	--
200 XRi	1990 & On	V-6	3.494	88.745	0.006	0.152	3.501	88.925	3.516	89.306 Note 1	--	--
225	1994 & On	V-6	3.621	91.973	0.001	0.0254	3.625	92.075	--	--	--	--
275	1990 & On	V-6	3.732	94.792	0.006	0.152	3.740 * Note 2	95.000 * Note 2	--	--	--	--

Note 1 Model 175 and 200hp -- 1990 -- S/N C100861 thru OC221449 have chrome cylinder walls. Therefore, the cylinders **CANNOT** be rebored. Contact the local marine dealer for a possible alternate solution. Models 1991 without chrome cylinder walls may be rebored.

Note 2 The cylinder walls on this model are Chrome finished. Therefore, the cylinders **CANNOT** be rebored. Contact the local marine dealer for a possible alternate solution.

REED STOP OPENING

MODEL H.P.	YEAR	CYL.	INCHES	mm.	REED VALVE GAP INCHES	mm.
135	1990 & On	V-6	NA	NA	0.020	0.51mm
150	1990 & On	V-6	NA	NA	0.020	0.51mm
150 XR4	1990 - 1991	V-6	NA	NA	0.020	0.51mm
150 XR6	1992 & On	V-6	NA	NA	0.020	0.51mm
150 XRi	1993 & On	V-6	NA	NA	—	—
175	1990 - 1991	V-6	NA	NA	0.020	0.51mm
175	1992 & On	V-6	NA	NA	0.020	0.51mm
175 XRi	1990 - 1991	V-6	NA	NA	—	—
175 XRi - SKI	1992 & On	V-6	NA	NA	—	—
200	1990 & On	V-6	NA	NA	0.020	0.51mm
200 XRi	1990 & On	V-6	NA	NA	—	—
225	1994 & On	V-6	NA	NA	0.020	0.51mm
275	1990 & On	V-6	0.130	3.3	0.020	0.51mm

LOWER UNIT BACKLASH

MODEL/ H.P.	YEAR	CYL.	GEAR RATIO	FOWARD GEAR	REVERSE GEAR
135	1990 & On	V-6	2.00:1	.015" - .022" .38mm - .56mm	.030" - .050" .76mm - 1.27mm
150	1990 & On	V-6	2.00:1	.015" - .022" .38mm - .56mm	.030" - .050" .76mm - 1.27mm
150 XR4	1990 - 1991	V-6	1.78:1	.016" - .019" .41mm - .48mm	.030" - .050" .76mm - 1.27mm
150 XR6	1992 & On	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
150 XRi	1993 & On	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
175	1990 - 1991	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
175	1992 & On	V-6	2.00:1	.015" - .022" .38mm - .56mm	.030" - .050" .76mm - 1.27mm
175XRi	1990 - 1991	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
175XRi SKI	1992 & On	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
200	1990 & On	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
200 XRi	1990 & On	V-6	1.87:1	.018" - .027" .46mm - .69mm	.030" - .050" .76mm - 1.27mm
225	1994 & On	V-6	1.64:1	0.17"-.028" .43mm-.71mm	.040"-.060" 1.01mm-1.52mm
275	1990 & On	V-6	1.64:1	.019" - .027" .48mm - .69mm	.030" - .050" .76mm - 1.27mm

Note 1 Optional gear ratio specifications are as follows:

Gear Ratio	Backlash
1.87:1	.018 - .017" (.46 - .69mm)
2.3:1	.018 - .023" (.46 - .58mm)

Note 2 Optional gear ratio specifications are as follows:

Gear Ratio	Backlash
2.00:1	.015 - .022" (.38 - .56mm)

TORQUE VALUES

POWERHEAD	MODEL 135 THRU 200 AND EFI	MODEL 225	MODEL 275
Crankcase Cover Bolts	Note 1	Note 2	Note 3
Flywheel Nut	120 Ftlb 162.7 Nm	125 Ftlb 169.5 Nm	100 Ftlb 136.0 Nm
Cylinder Head Bolts	Note 4	Note 5	17 Ftlb 23.0 Nm
Exhaust Manifold Cover	200 Inlb 22.5 Nm Note 6	N/A	180 Inlb 20.3 Nm Note 6
Reed Block Mounting Bolts	80 Inlb 9.0 Nm	90 Inlb 10.2 Nm	60 Inlb 6.7 Nm
Reed Attaching Screws	25 Inlb 2.8 Nm	25 Inlb 2.8 Nm	25 Inlb 2.8 Nm
Relief Valve Cover Bolts	150 Inlb 16.9 Nm	150 Inlb 16.9 Nm	150 Inlb 16.9 Nm
Upper End Cap Bolts	150 Inlb 16.9 Nm	N/A	N/A
Lower End Cap Bolts	80 Inlb 9.0 Nm	85 Inlb 9.6 Nm	150 Inlb 16.9 Nm
Oil Pump Drive Gear Bolt	8 Inlb 0.9 Nm	N/A	N/A
Connecting Rod Cap Bolts	Note 7	Note 7	Note 7
Stator Mounting Bolts	50 Inlb 5.6 Nm	100 Inlb 11.3 Nm	150 Inlb 16.9 Nm
Spark Plugs	20 Ftlb 27.1 Nm	20 Ftlb 27.1 Nm	17 Ftlb 23.0 Nm
Fuel Pump to Crankcase	55 Inlb 6.2 Nm	60 Inlb 6.7 Nm	55 Inlb 6.2 Nm
Powerhead to Drive Shaft Housing	—	—	30 Ftlb 40.7 Nm

TORQUE VALUES

POWERHEAD (cont.)	MODEL 135 THRU 200 AND EFI	MODEL 225	MODEL 275
Carburetor Adaptor Plate	N/A	N/A	60 Inlb 6.7 Nm
Thermostat Cover	200 Inlb 22.6 Nm	Note 5	150 Inlb 16.9 Nm
Temperature Sensor	200 Inlb 22.6 Nm	200 Inlb 22.6 Nm	N/A
Oil Injection Pump Mount Bolts	25 Inlb 2.8 Nm	55 Inlb 6.2 Nm	60 Inlb 6.8 Nm
LOWER UNIT GEAR HOUSING			
Pinion Gear Nut	75 Ftlb 101.7 Nm Note 6	100 Ftlb 136.0 Nm Note 6	70 Ftlb 94.9 Nm Note 6
Water Pump Bolts	35 Inlb 3.9 Nm	60 Inlb 6.8 Nm	60 Inlb 6.8 Nm
Shift Shaft Bushing	50 Ftlb 67.7 Nm	60 Inlb 6.8 Nm	50 Ftlb 67.7 Nm
Propeller Nut	55 Ftlb 74.6 Nm	55 Ftlb 74.6 Nm	55 Ftlb 74.6 Nm
Bearing Carrier Nut	210 Ftlb 284.7 Nm	210 Ftlb 284.7 Nm	210 Ftlb 284.7 Nm
Gear Housing to Drive Shaft	Note 8	Note 8	40 Ftlb 54.2 Nm
Water Pump Nuts	50 Inlb 5.6 Nm	N/A	N/A
Upper Drive Shaft Bearing Nut	100 Ftlb 136.0 Nm	70 Ftlb 94.9 Nm	100 Ftlb 136.0 Nm
Anode/Trim Tab Retaining Bolt	25 Ftlb 33.9 Nm	45 Ftlb 61.0 Nm	15 Ftlb 20.3 Nm

TORQUE NOTES

1. Apply light oil to the threads and face of all bolts. First tighten the eight 3/8" bolts in three progressive stages to a torque value of 38.0 ft lbs (51.5 Nm). Tighten the remaining 5/16" bolts in three progressive stages to a torque value of 15 ft lbs (20.3 Nm).

2. Apply light oil to the threads and face of all bolts. First tighten the eight M10 x 1.5 mm bolts in three progressive stages to a torque value of 30.0 ft lbs (40.7 Nm) and then rotate the bolts an additional 90^0 (1/4 turn). Tighten the remaining fourteen M8 x 1.25 mm bolts in three progressive stages to a torque value of 28.0 ft lbs (37.9 Nm).

3. Apply light oil to the threads and face of all bolts. Tighten bolts #1 thru #4 in three progressive stages to a torque value of 30.0 ft lbs (40.7 Nm). Next, tighten bolts #5 thru #14 in three progressive stages to a torque value of 30.0 ft lbs (40.7 Nm).

4. On 1990 thru 1993 models apply light oil to the threads and face of all bolts. Tighten the head bolts in three progressive stages to a torque value of 40.0 ft lbs (54.2 Nm). Re-torque the cylinder head bolts again after the powerhead has been operated for the first 1/2 to 1.0 hour.
   On 1994 models apply light oil to the threads and face of all bolts. Tighten the head bolts in three progressive stages to a torque value of 30.0 ft lbs (40.7 Nm) and then rotate the bolts an additional 90^0 (1/4 turn). Re-torque of the head bolts on 1994 and later models is not required.

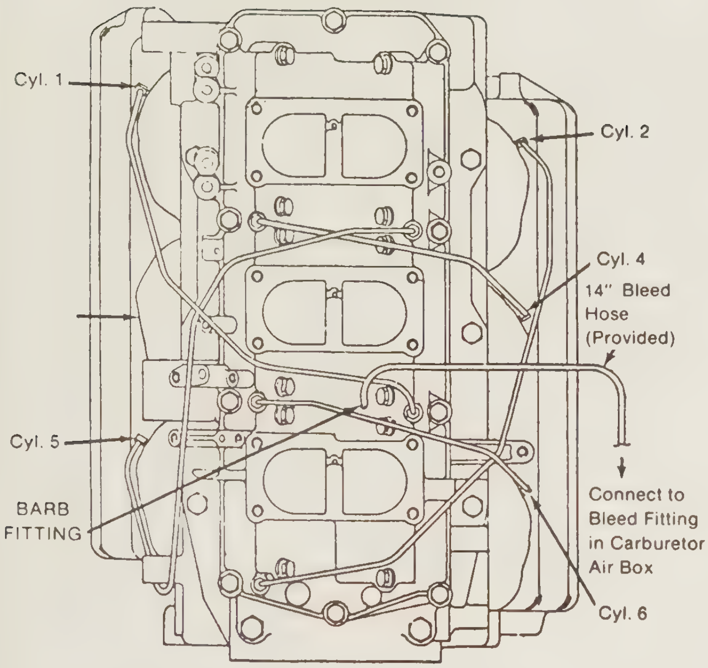
5. Apply light oil to the threads and face of all bolts. Tighten bolts #18 and #20 in three progressive stages to a torque value of 30.0 ft lbs (40.7 Nm) and then rotate the two bolts an additional 90^0 (1/4 turn). Now, tighten all the remaining head bolts in three progressive stages to a torque value of 20.0 ft lbs (27.1 Nm). Rotate all the head bolts, except # 18 and # 20, an additional 90^0 (1/4 turn).

6. Apply thread sealant Loctite #271 or equivalent, to the threads of the fastener.

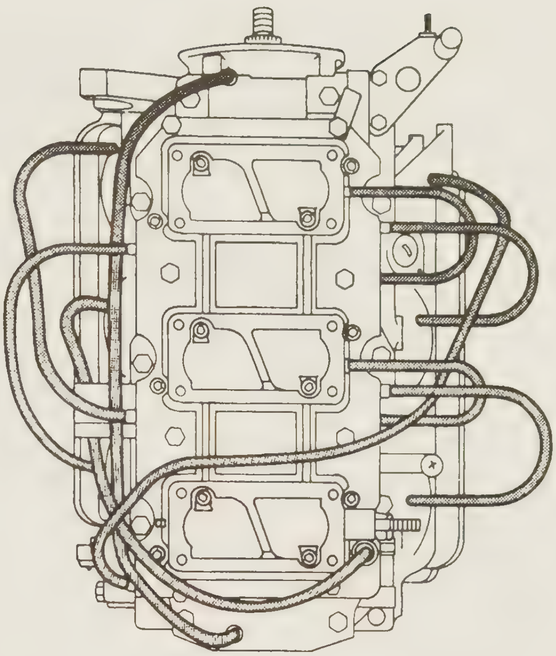
7. On 1990 and 1991 models, apply thread sealant Loctite #271 or equivalent, to the threads of the rod cap bolts. Tighten the bolts to a torque value of 30 ft lbs (40.7 Nm).
   On 1992 and later models, apply light oil to the threads and face of all rod bolts. Tighten the rod bolts to a torque value of 15 inch lbs (1.7 Nm). Next, tighten the rod bolts to a torque value of 30 ft lbs (40.7 Nm). Tighten the rod bolts on 1992 and later models an additional 90^0 (1/4 turn) after the 30 ft lbs torque value has been attained.

8. Tighten the 3/8" nuts to a torque value of 55 ft lbs (74.6 Nm).
   Tighten the 7/16" nuts or bolts to a torque value of 65 ft lbs (88.1 Nm).

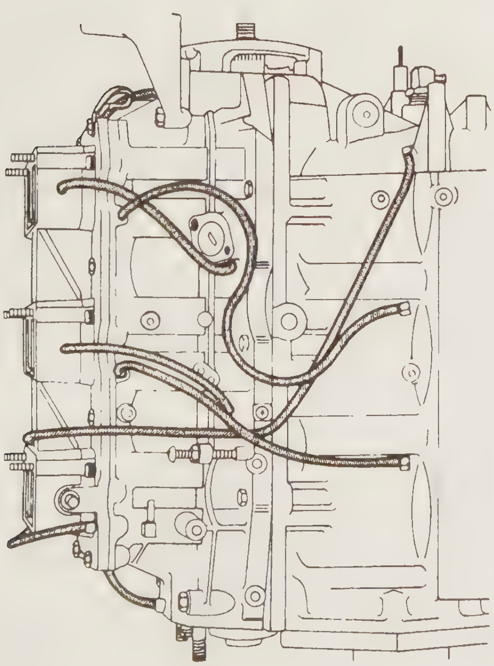
BLEED LINE ROUTING
CARBURETED MODELS



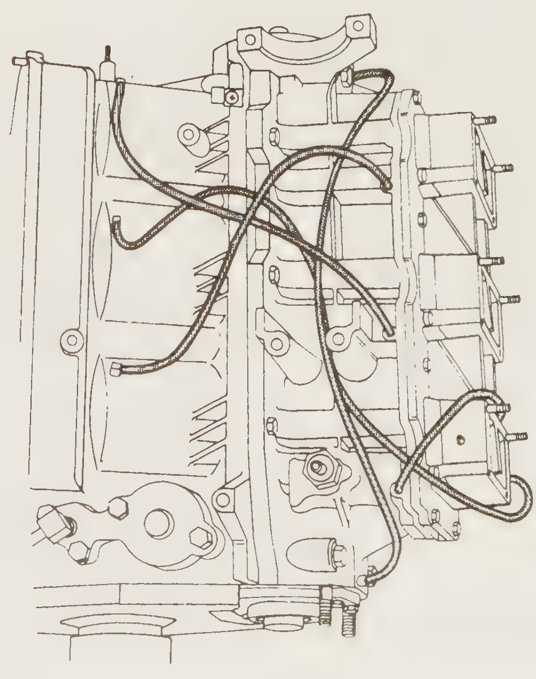
FRONT VIEW *-- Model 135hp thru 200hp -- 1990 and on -- with vertical mounted reeds.*



FRONT VIEW *-- Model 135hp thru 200hp -- 1990 and on -- with horizontal mounted reeds.*

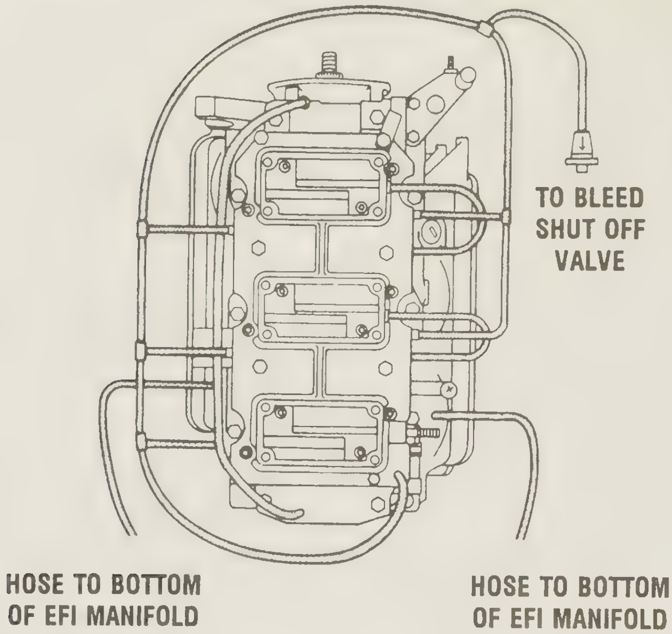


PORT SIDE *-- Model 135hp thru 200hp -- 1990 and on -- with horizontal mounted reeds.*

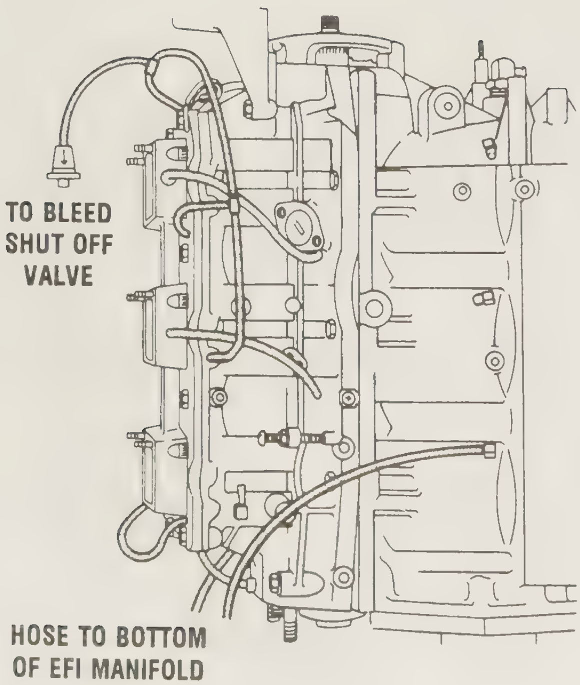


STARBOARD SIDE *-- Model 135hp thru 200hp -- 1990 and on -- with horizontal mounted reeds.*

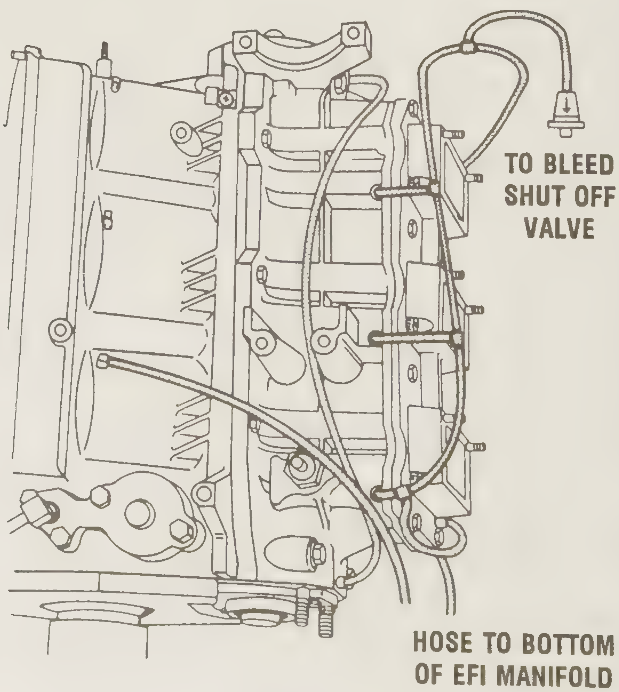
BLEED LINE ROUTING
FUEL INJECTED MODELS



FRONT VIEW *-- Model 150XRi, 175XRi and 200XRi.*

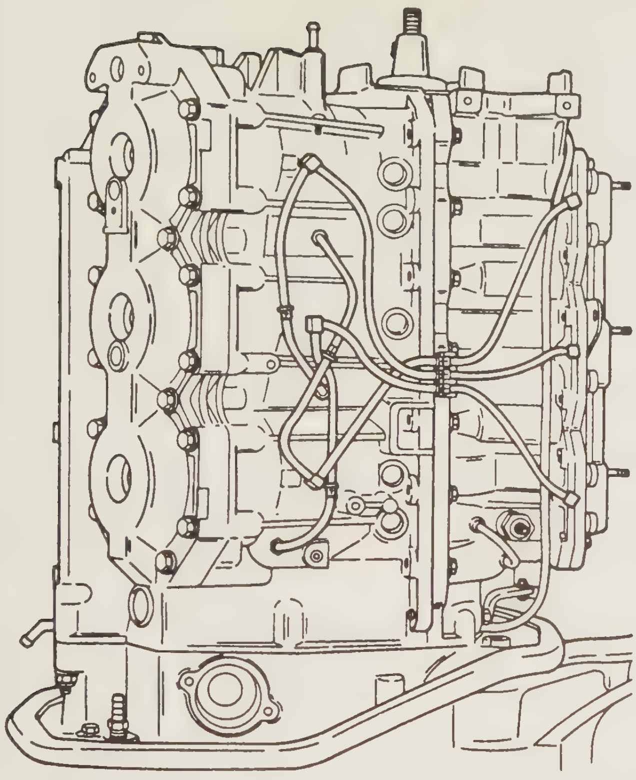


PORT SIDE *-- Model 150XRi, 175XRi and 200XRi.*

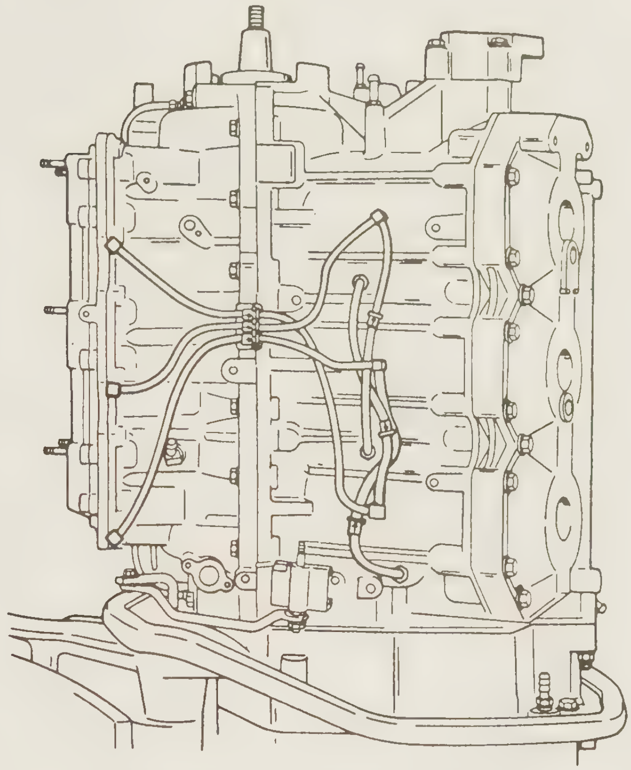


STARBOARD SIDE *-- Model 150XRi, 175XRi and 200XRi.*

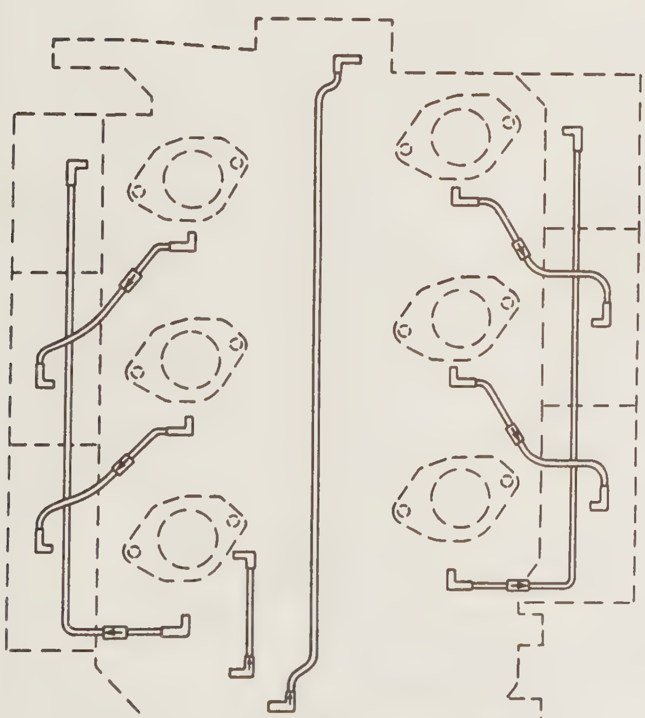
BLEED LINE ROUTING -- LARGE HORSEPOWER MODELS WITH CARBURETORS



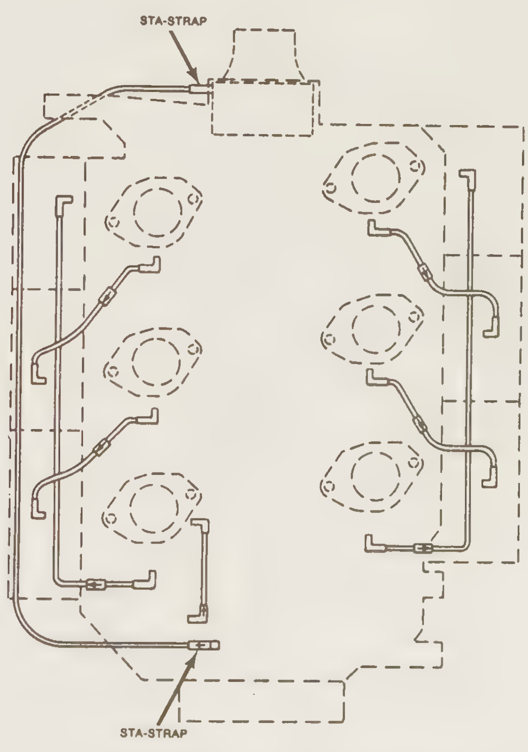
***STARBOARD SIDE** -- Model 225hp -- 1994 & On.*



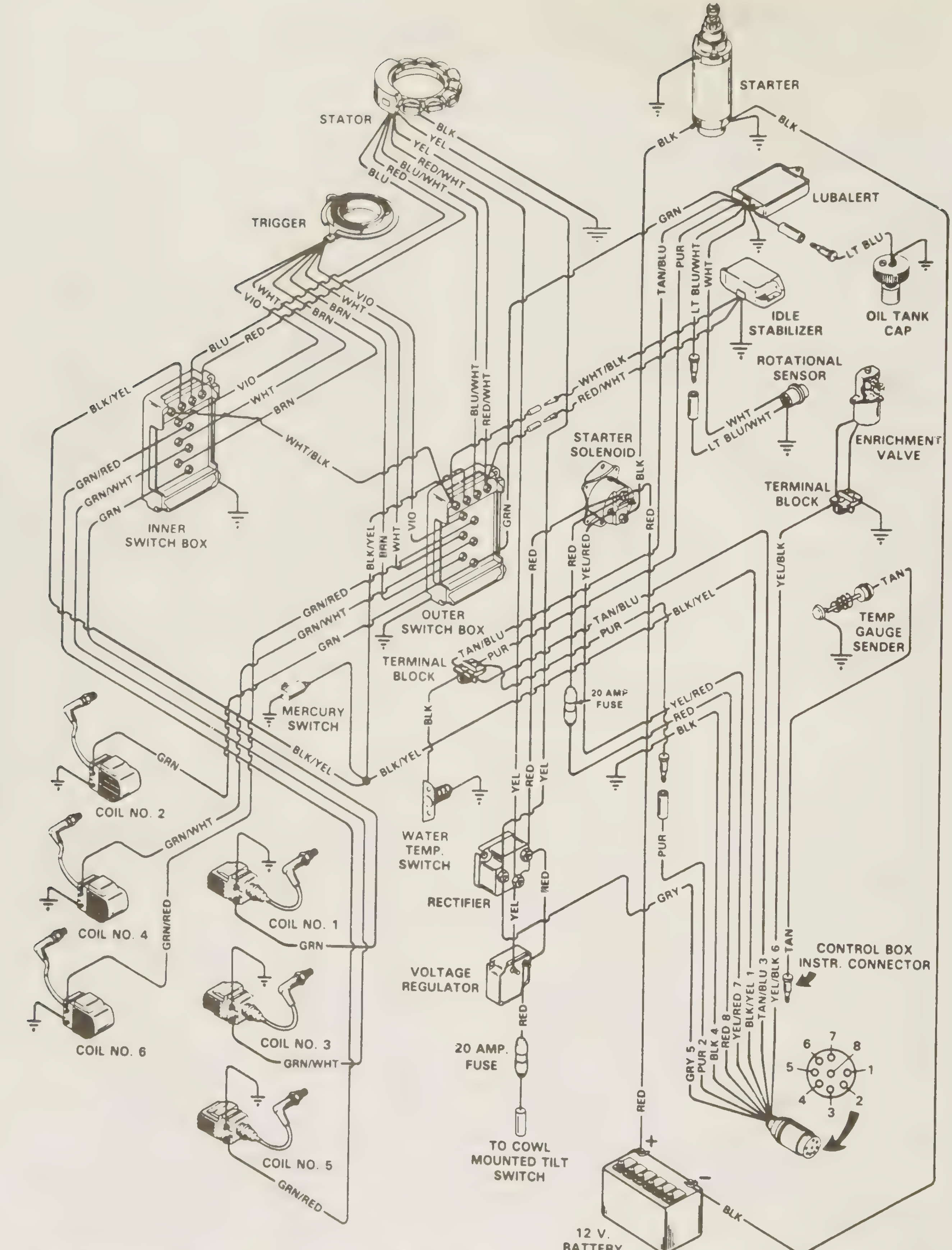
***PORT SIDE** -- Model 225hp -- 1994 & On.*



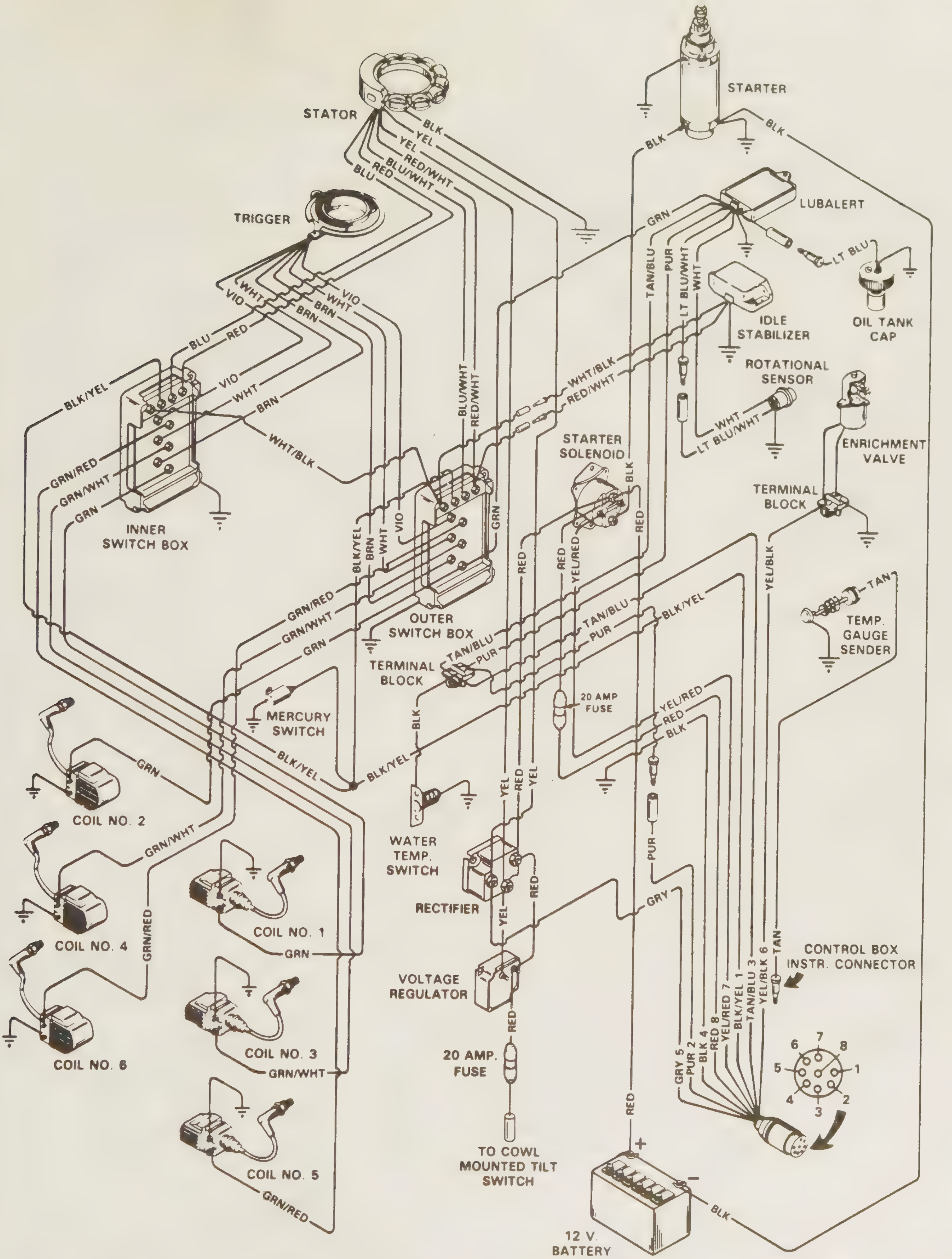
***FRONT VIEW** -- Model 275hp -- 1990 & On.*
S/N OD038957-038959 also OD038971 & Higher.



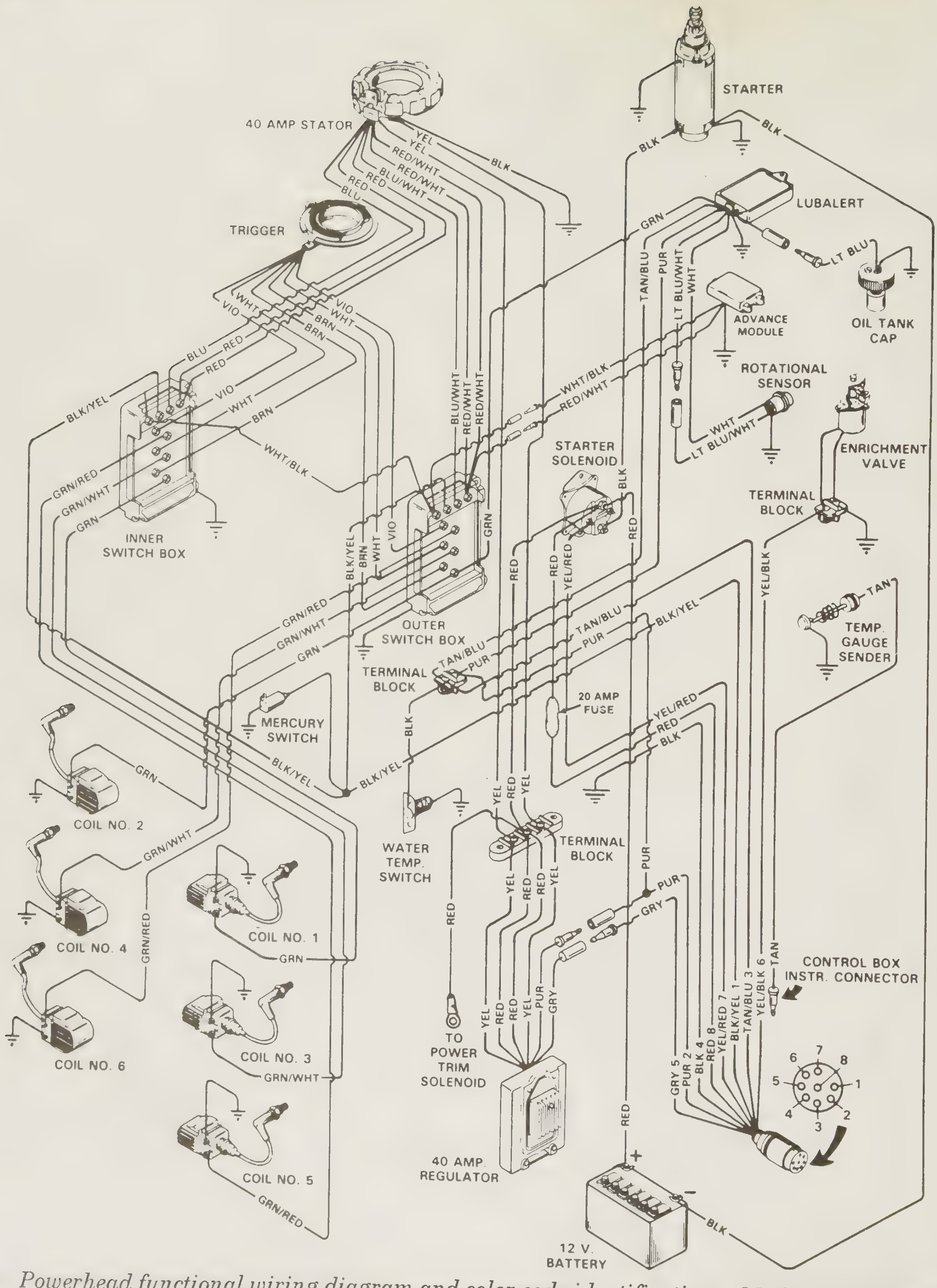
***FRONT VIEW** -- Model 275hp -- 1990 & On.*
S/N L-OD086818 & Higher; XL-OD086876 & Higher;
XXL-OD090719 & Higher.



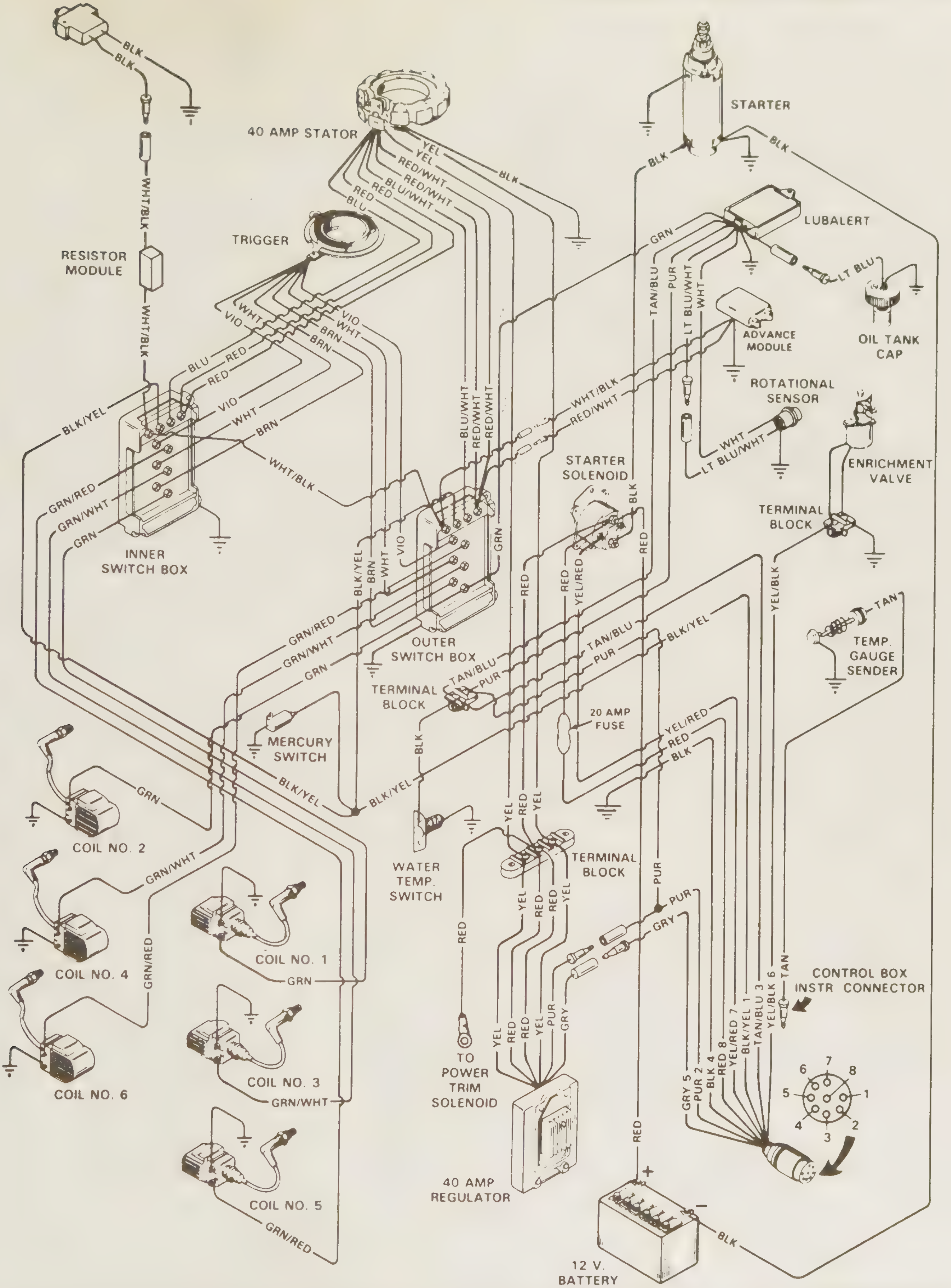
Powerhead functional wiring diagram and color code identification -- Model 135, 150 & 175hp with ***16 Amp Stator*** *-- 1990 - 1992.*



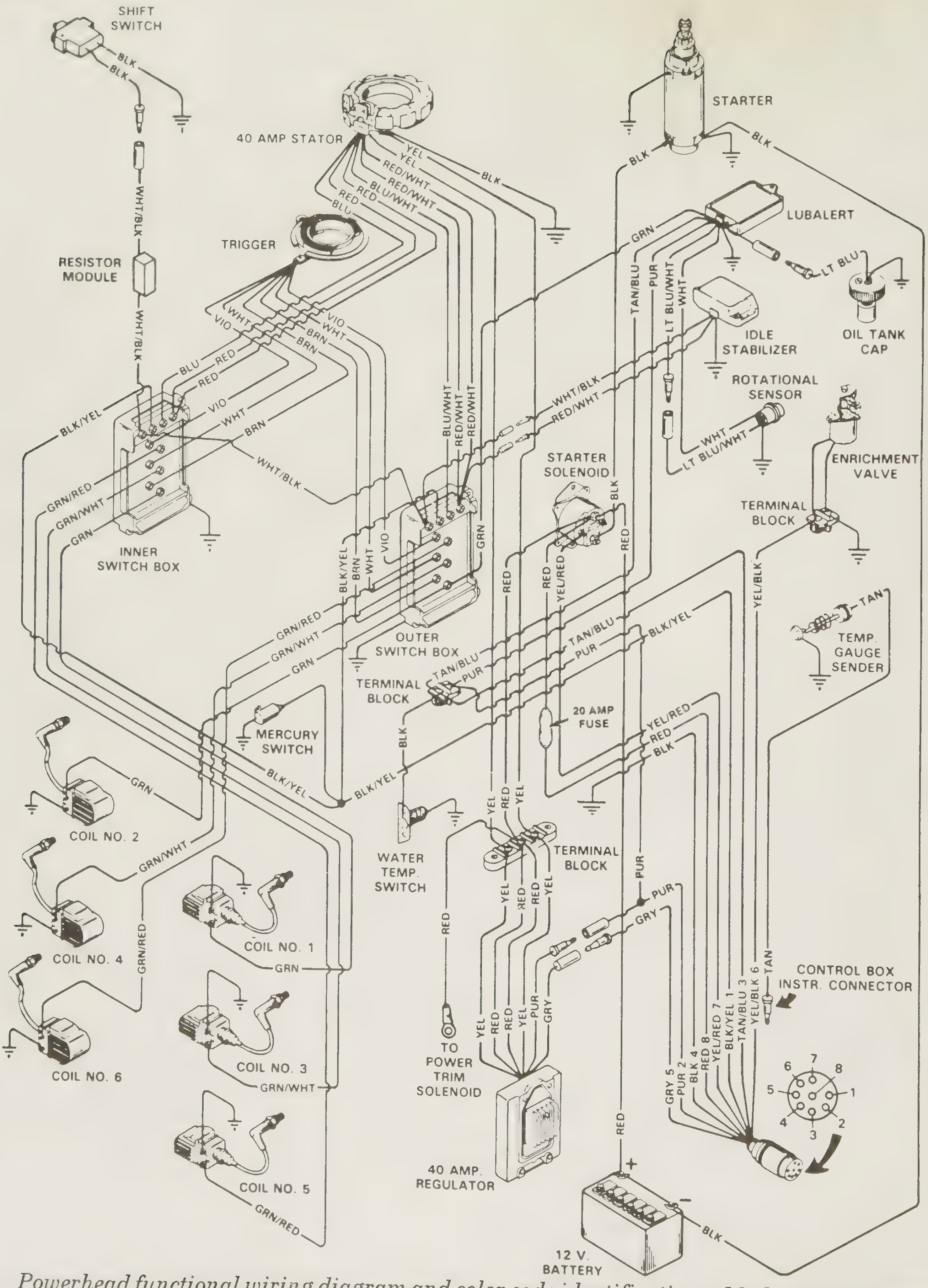
*Powerhead functional wiring diagram and color code identification -- Model 135, 150, 175 and 200hp with **40-Amp Stator** -- 1990 - 1992. The model 200hp -- S/N OC291560-OD077247 equipped with idle stabilizer.*



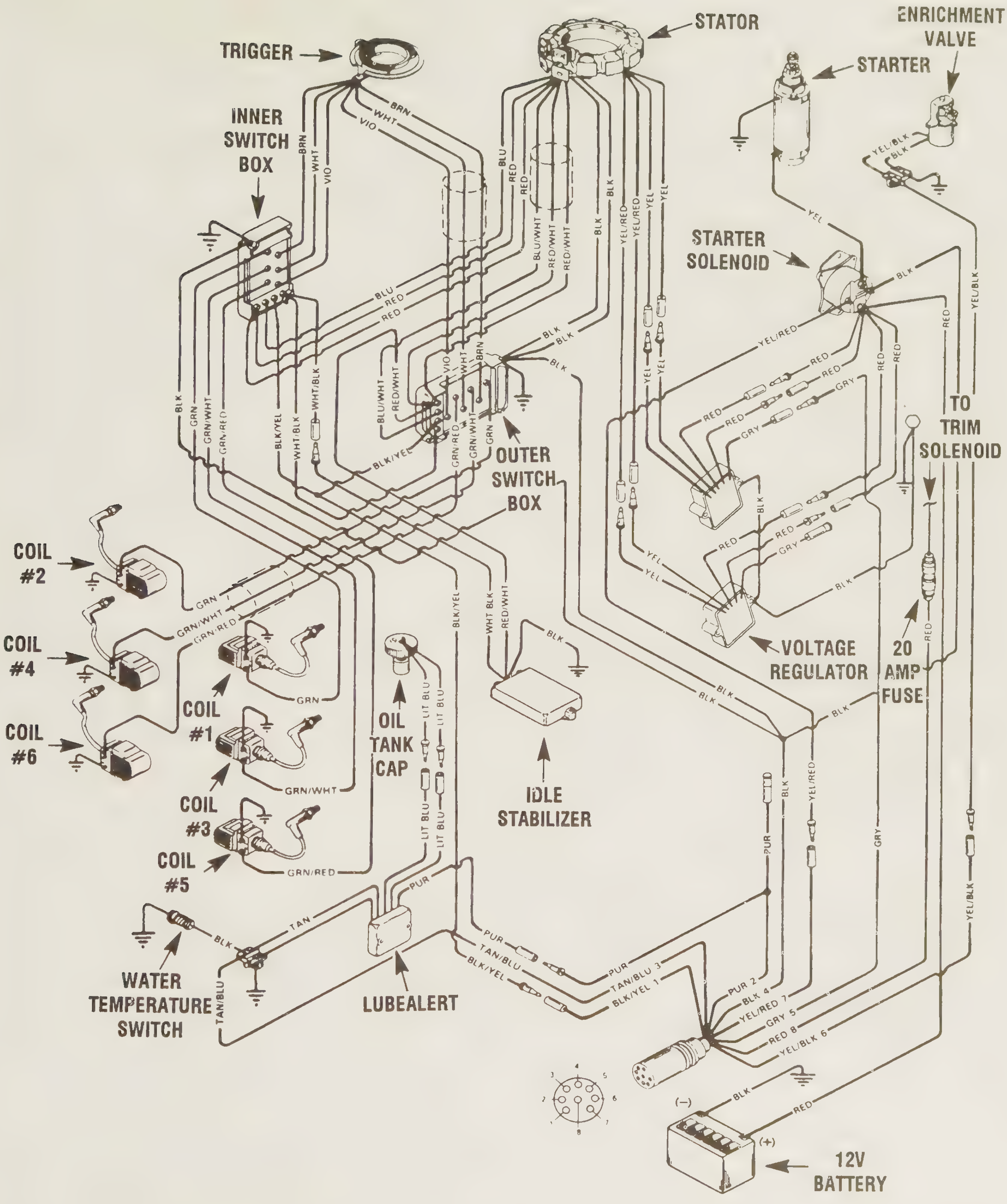
*Powerhead functional wiring diagram and color code identification -- Model 200hp Serial No. OD077247 and higher with **40-Amp Alternator** -- 1990 - 1992.*



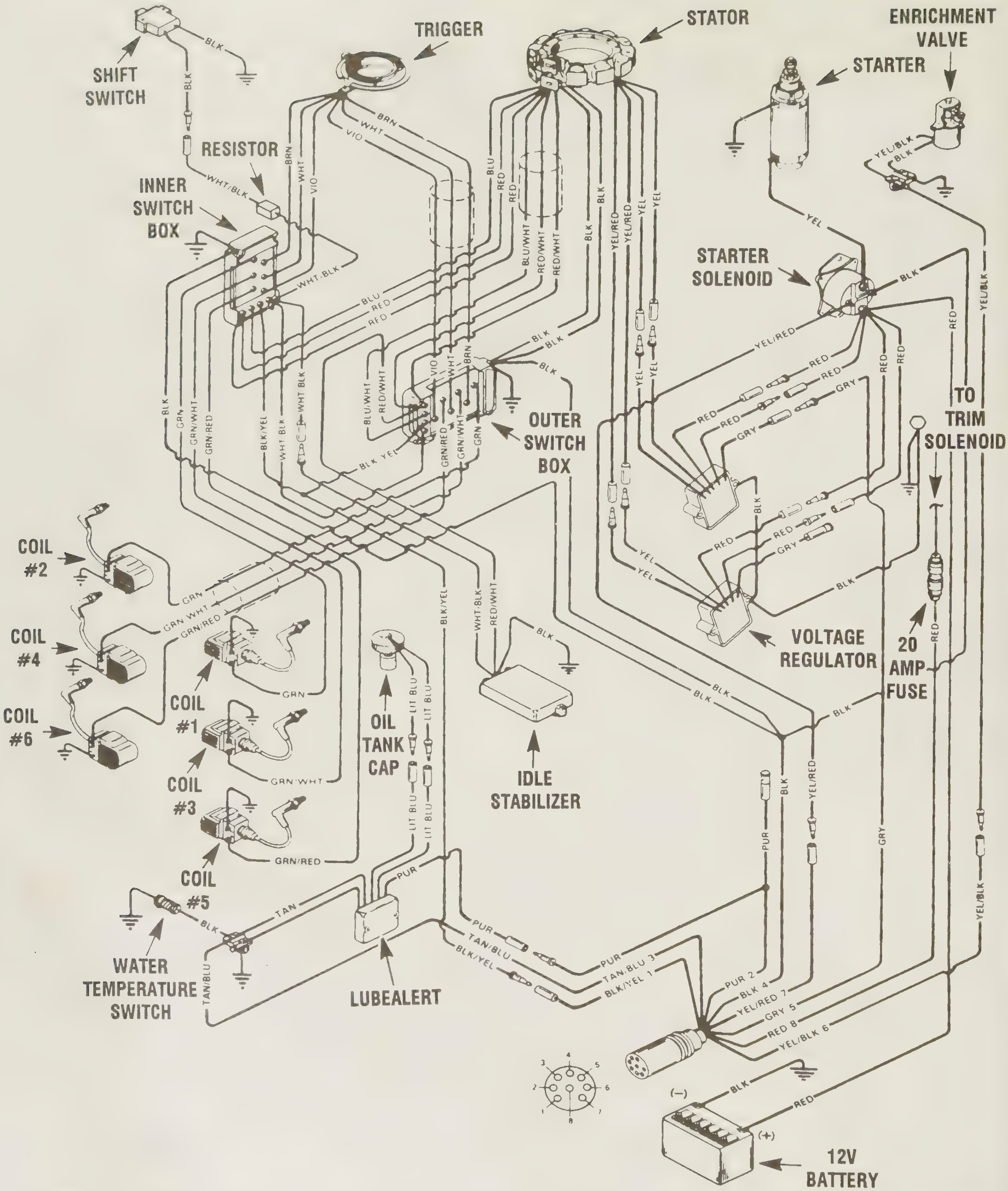
*Powerhead functional wiring diagram and color code identification -- Model XR4/Magnum II -- with **40-Amp Alternator** -- Serial No. C247591 thru C254931 equipped with Idle Stabilizer/Advance Module -- 1990-1992.*



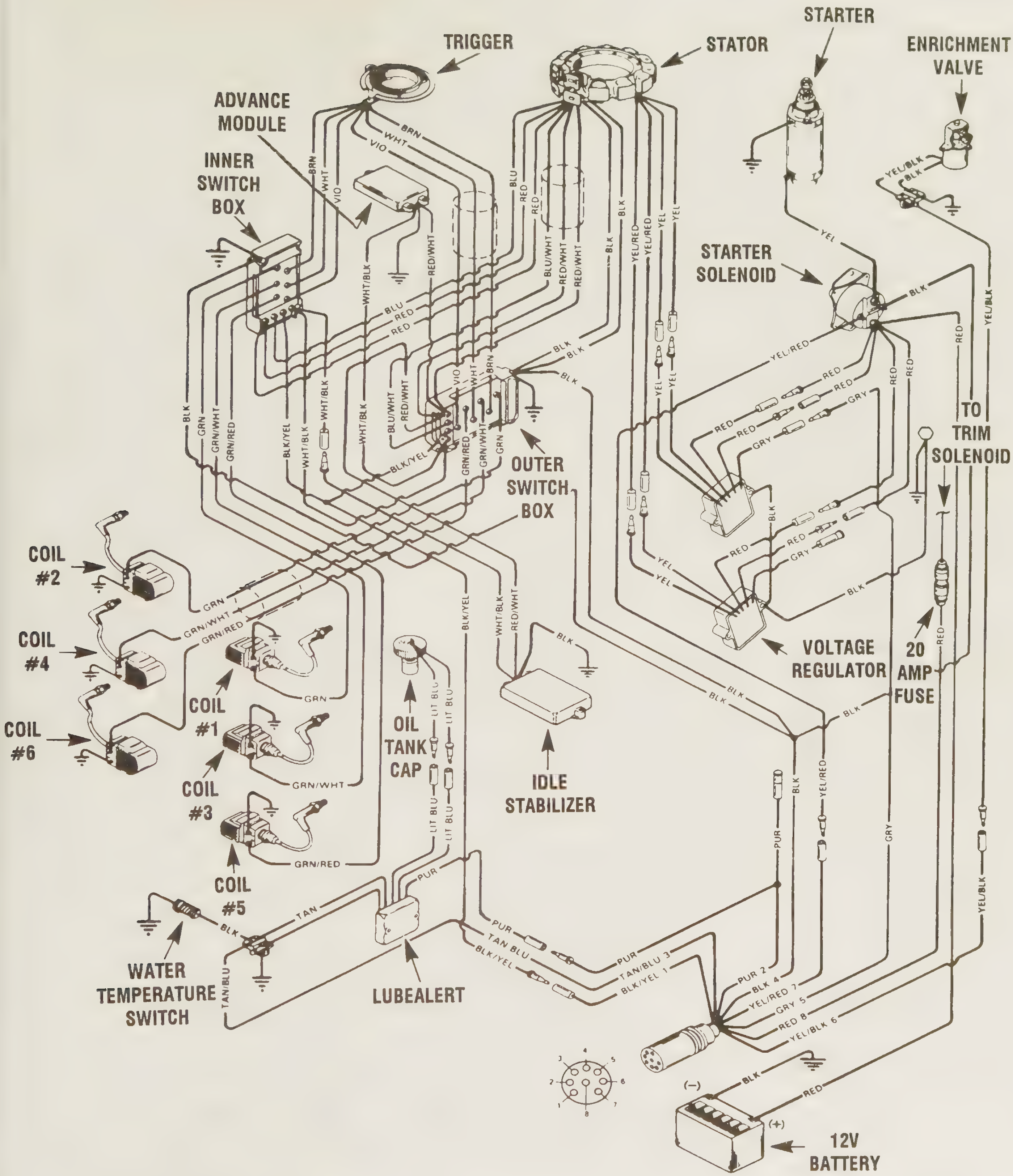
Powerhead functional wiring diagram and color code identification -- Model XR4/Magnum II -- with ***40-Amp Alternator*** *-- Serial No. C254932 and higher -- equipped with Idle Stablizer -- 1990 - 1992.*



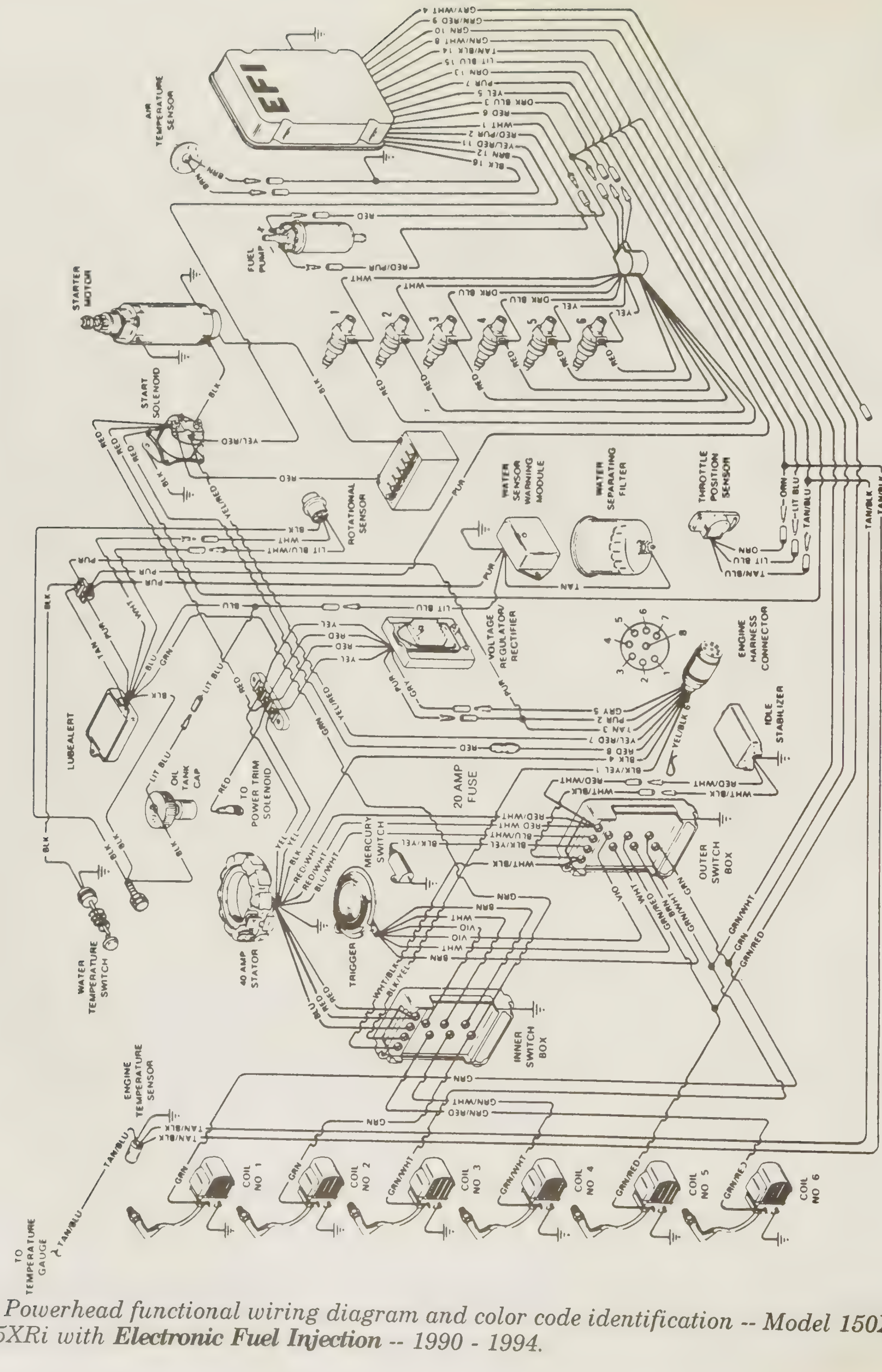
Powerhead functional wiring diagram and color code identification -- Model 135 and 150hp with ***Dual Voltage Regulator*** *-- 1993 - 1994.*



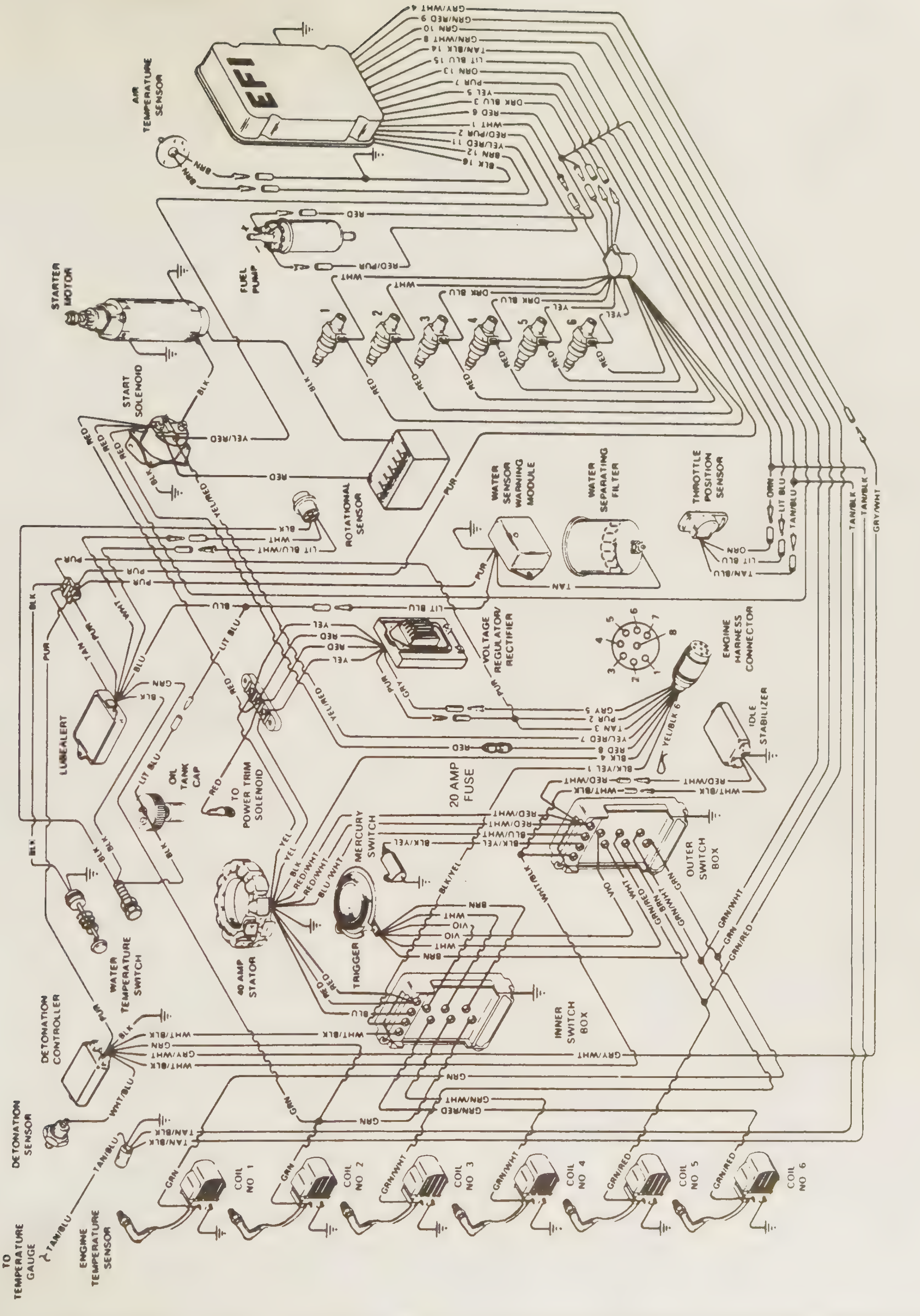
Powerhead functional wiring diagram and color code identification -- Model XR6/Magnum III, 175 and 200hp -- both with carburetor -- 1993 - 1994. Model 200 -- Serial No. OD122747 and higher.



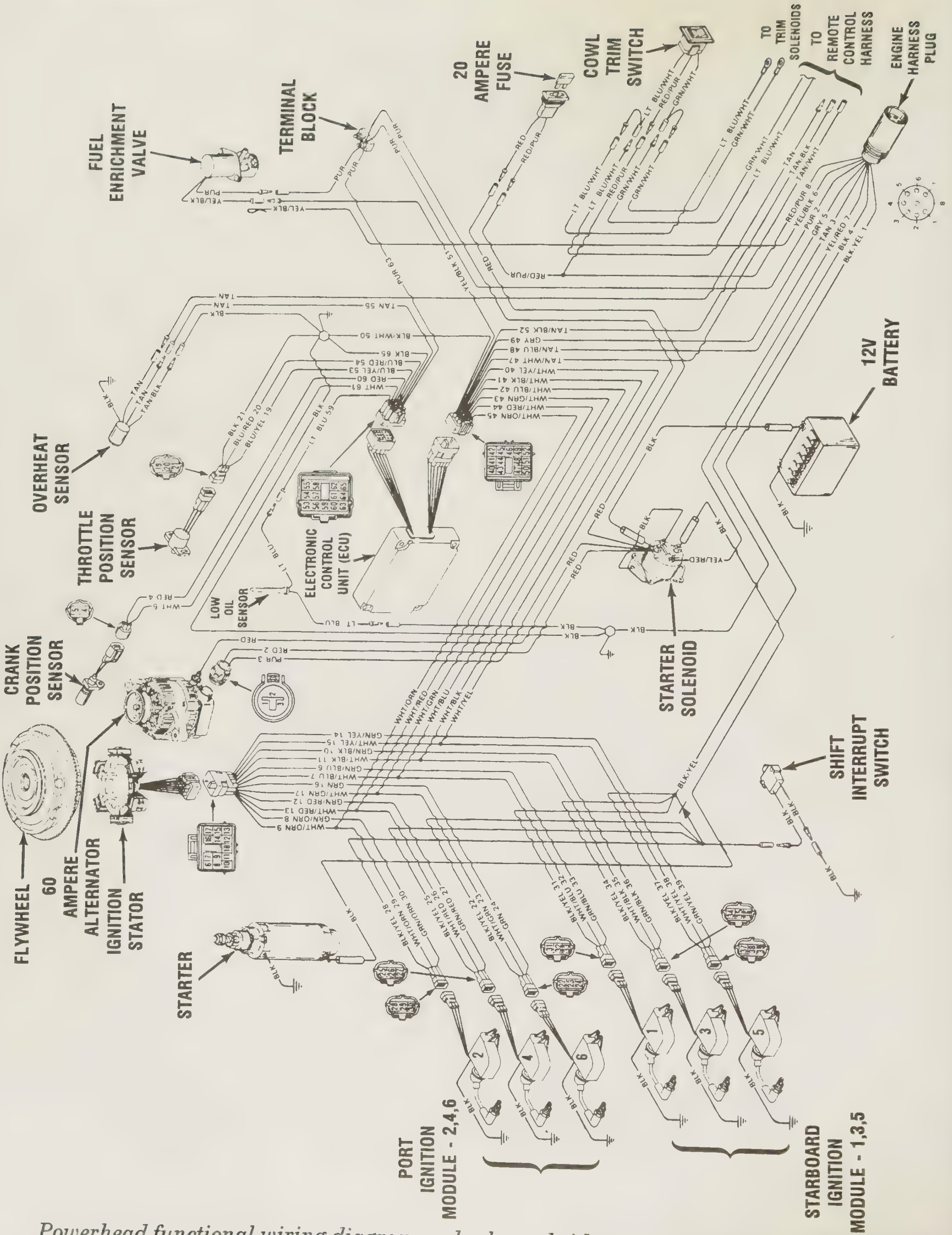
Powerhead functional wiring diagram and color code identification -- Model 200 with carburetor -- Serial No. OD077248 thru No. OD122746. When servicing these powerheads, the Advance Module should be removed to prevent the possibility of detonation.



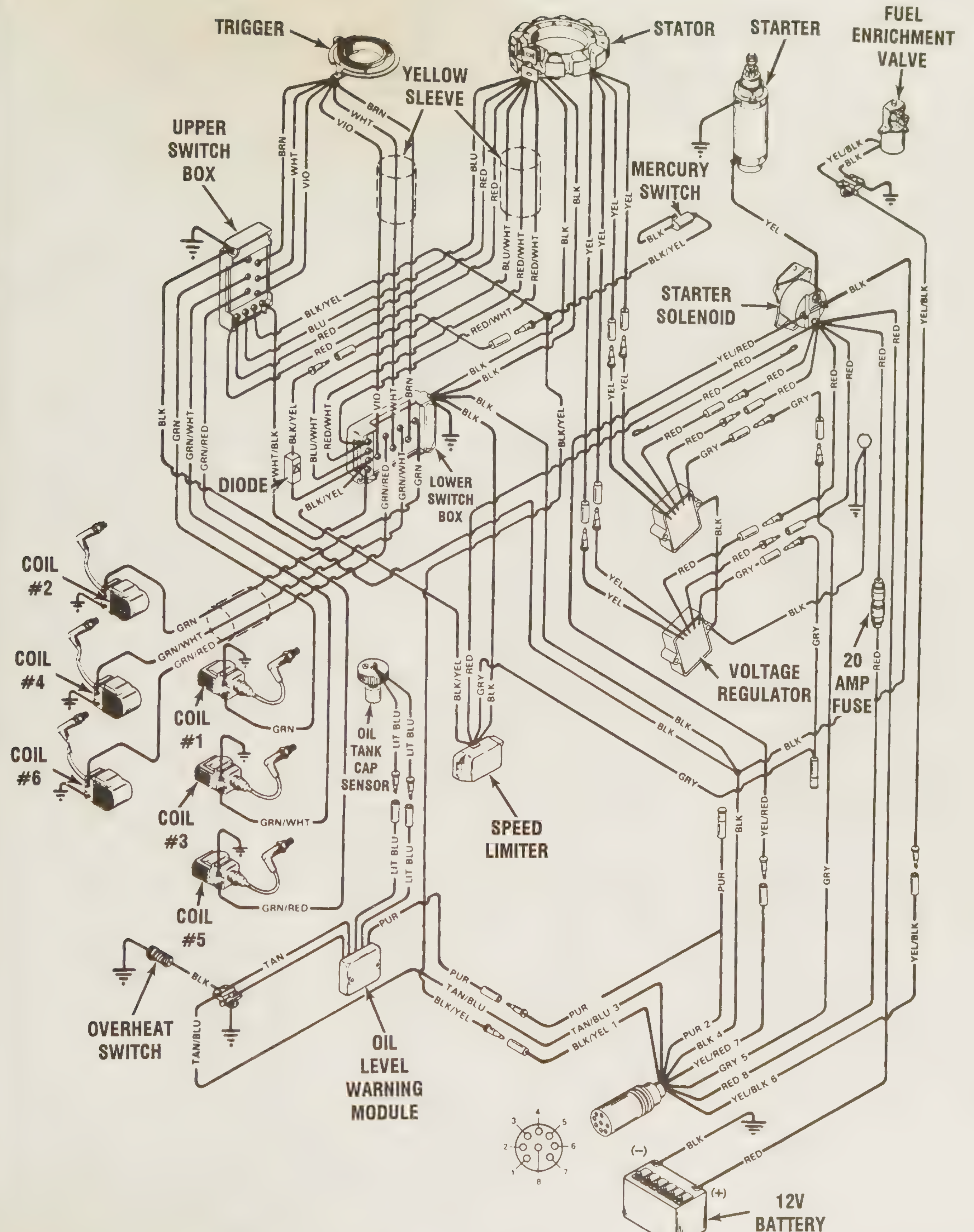
*Powerhead functional wiring diagram and color code identification -- Model 150XRi and 175XRi with **Electronic Fuel Injection** -- 1990 - 1994.*



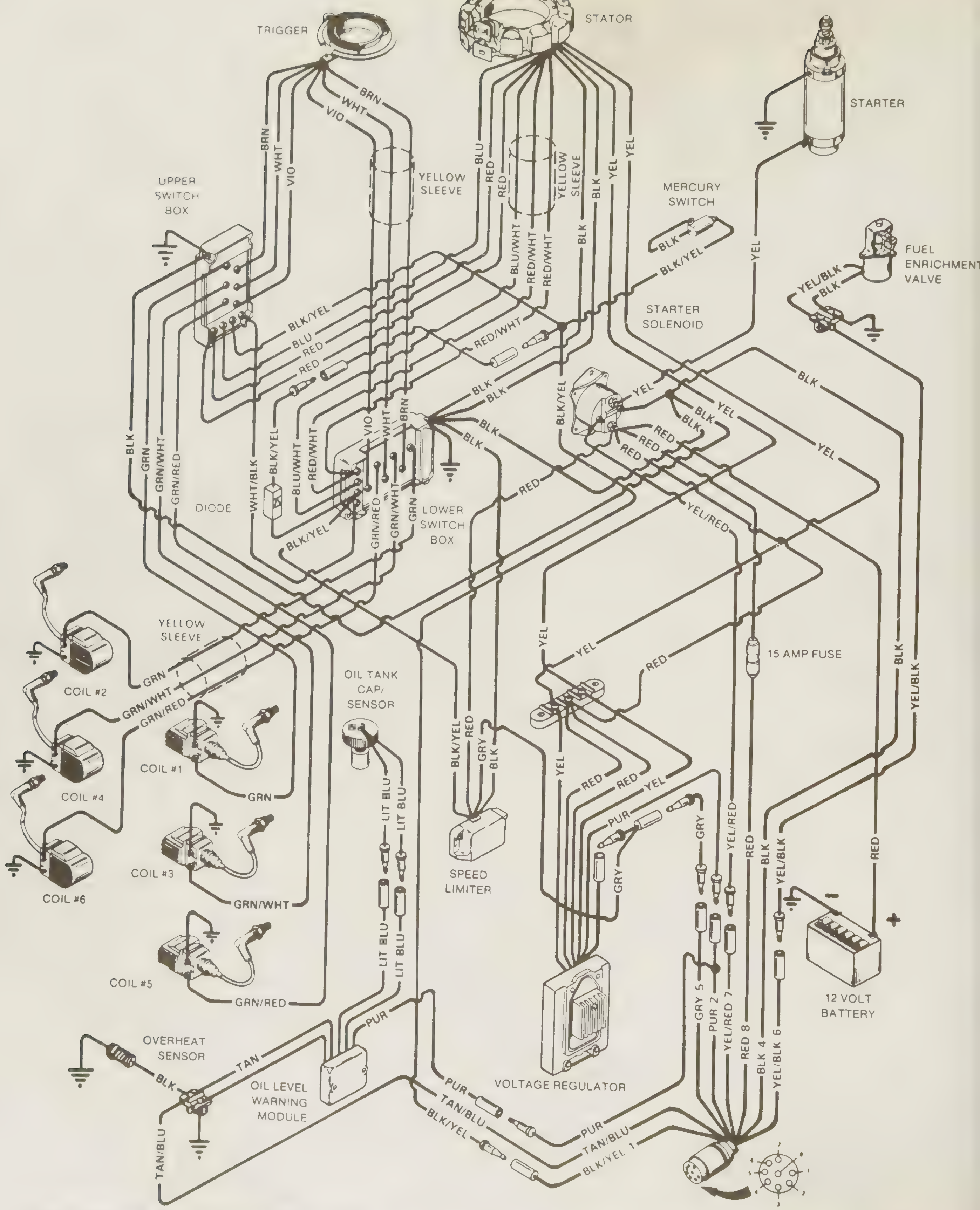
*Powerhead functional wiring diagram and color code identification -- Model 200XRi with **Electronic Fuel Injection** -- 1990 - 1994.*



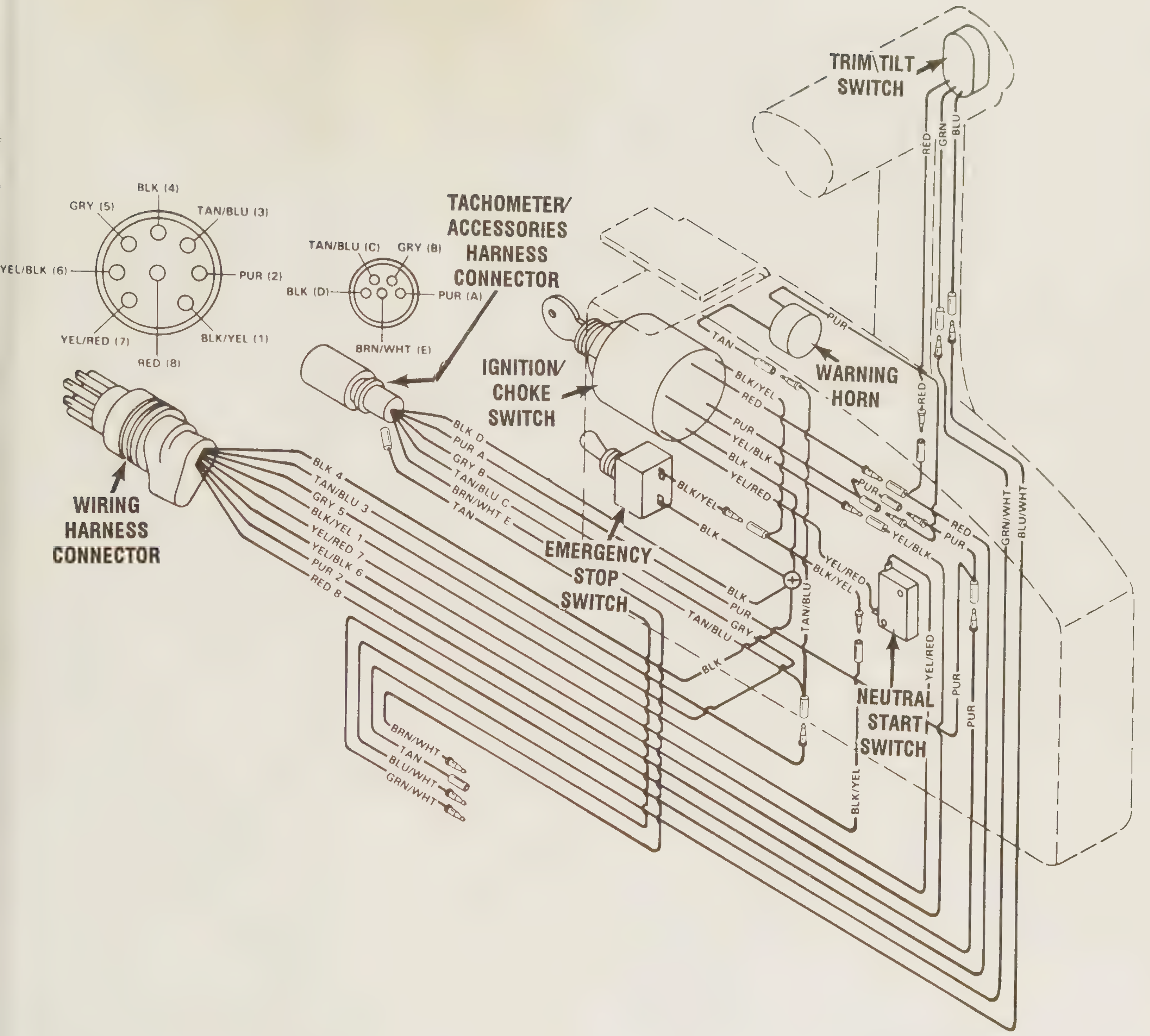
Powerhead functional wiring diagram and color code identification -- Model 225hp -- 1994 and on.



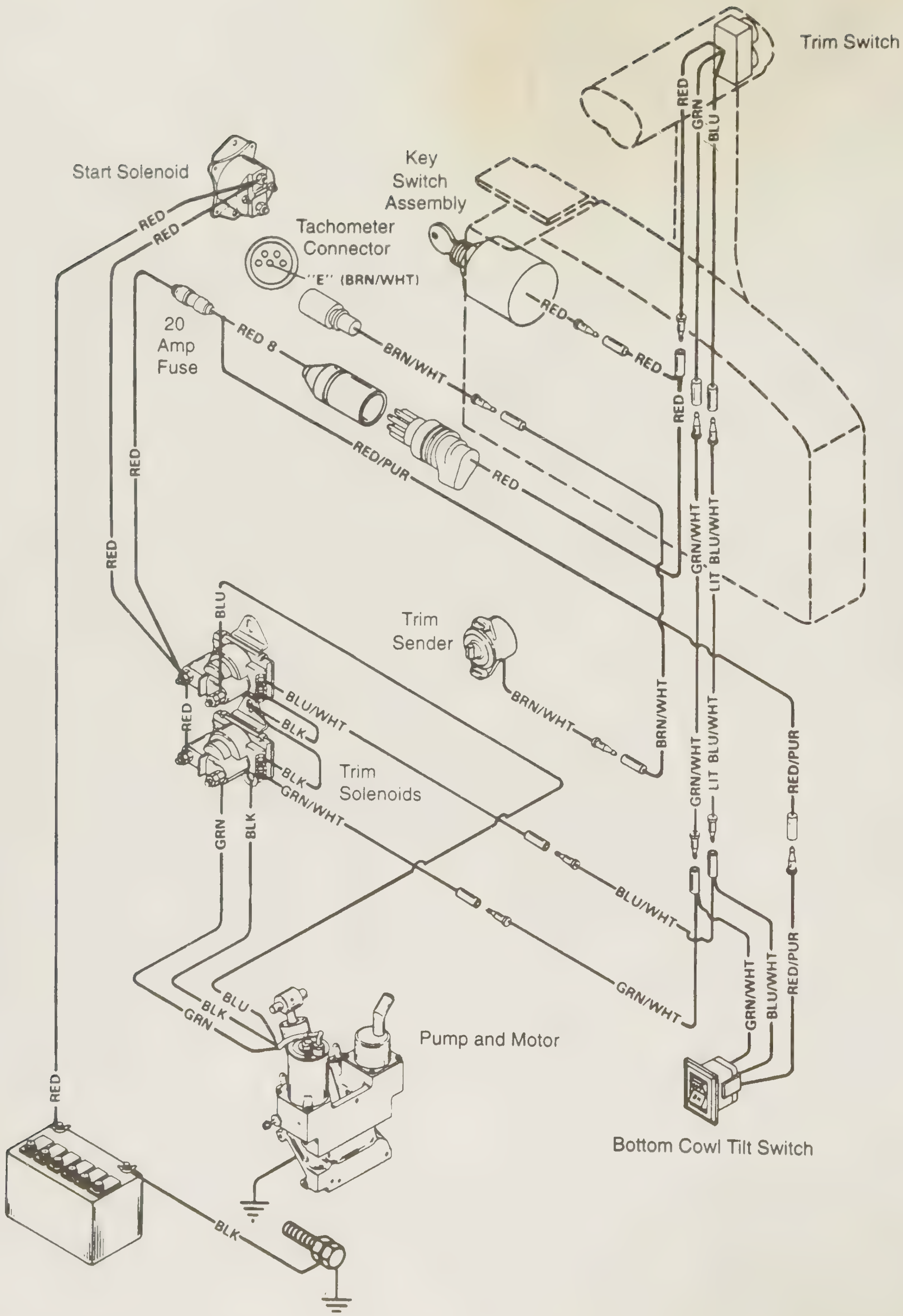
Powerhead functional wiring diagram and color code identification -- Model 275hp with ***40-Amp Alternator*** *and* ***Dual Regulator*** *-- 1994.*



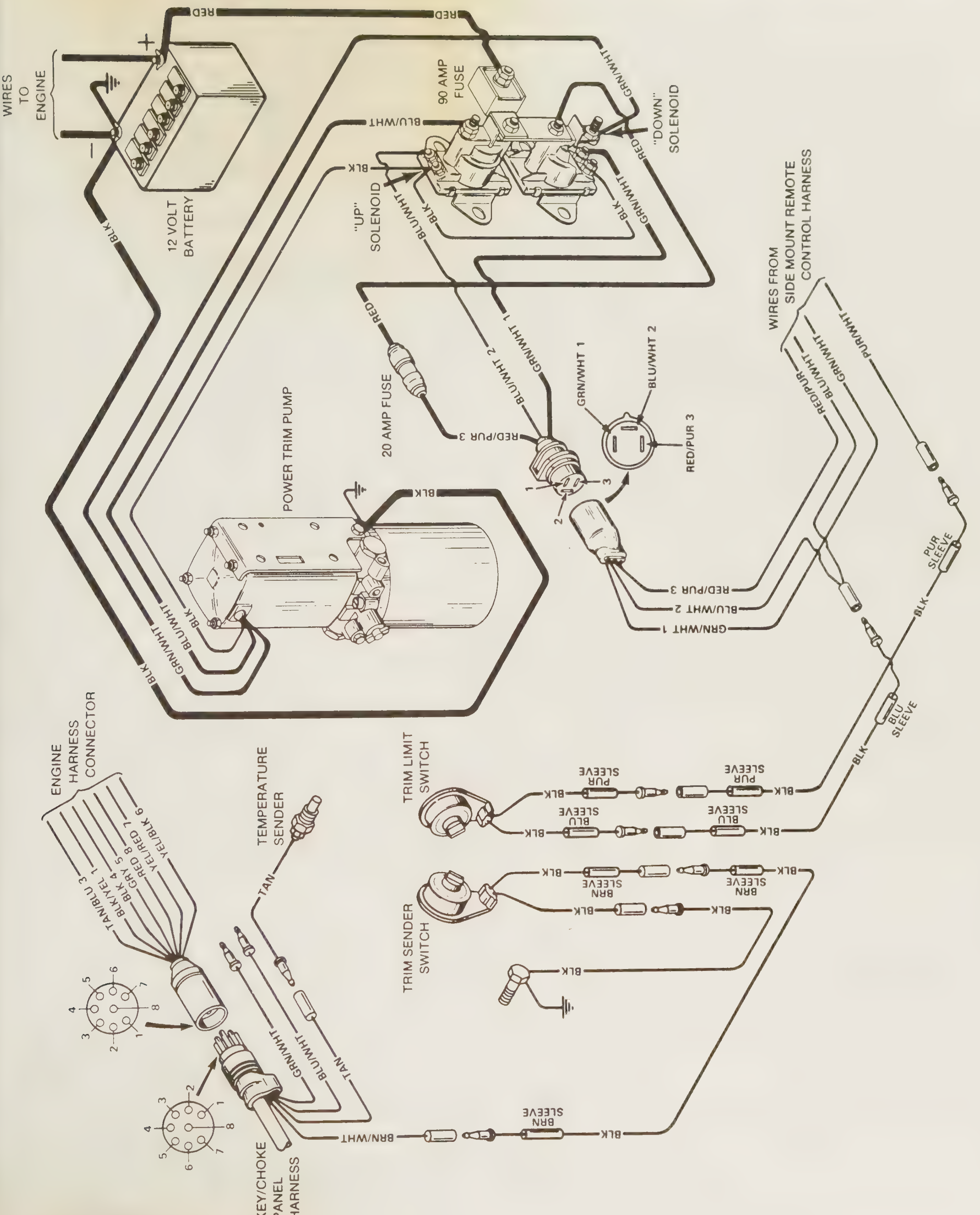
Powerhead functional wiring diagram and color code identification -- Model 275hp with ***40-Amp Alternator*** *and* ***Single Regulator*** *-- 1990 - 1993.*



Functional wiring diagram for the Commander 2000 side mount remote control ***WITH*** *warning horn, power trim/tilt, and electric start. Wire color code identification is indicated.*



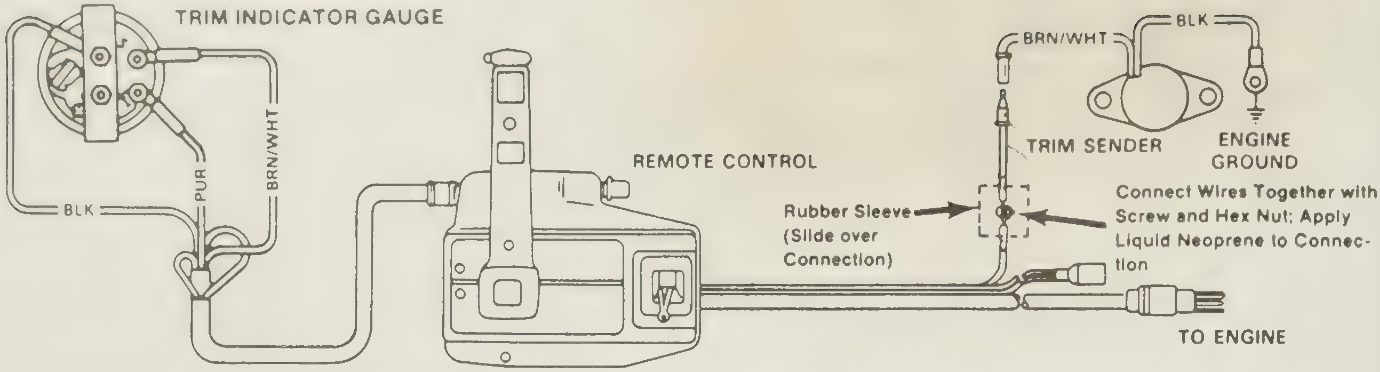
Functional wiring diagram and color code identification for a typical trim/tilt System "A" installed with the Model 135 thru 225hp powerhead.



Functional wiring diagram and color code identification for a typical trim/tilt System with ***Fuse*** *installed with the Model 275 hp powerhead -- 1990 and on.*

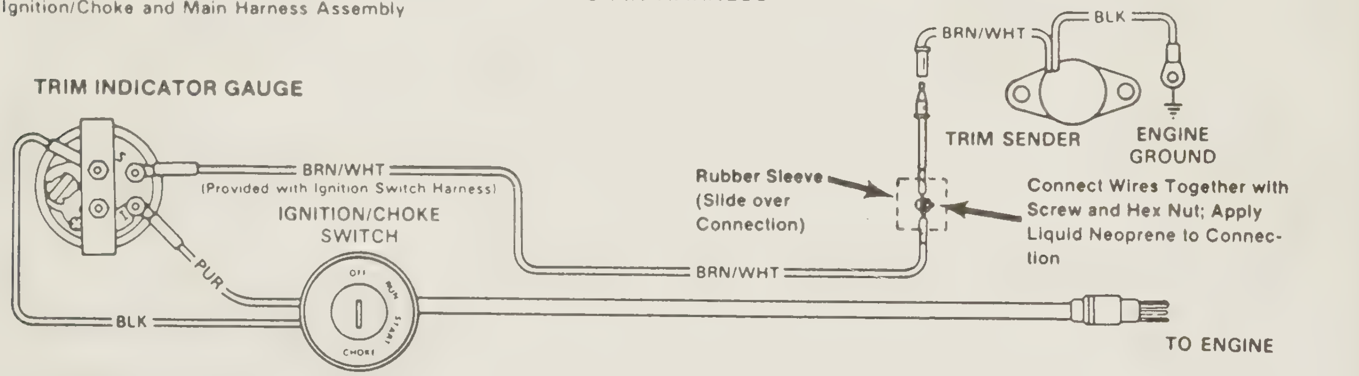
Wiring Diagram - For boats equipped with Quicksilver Commander Series side mount remote control

8 PIN HARNESS



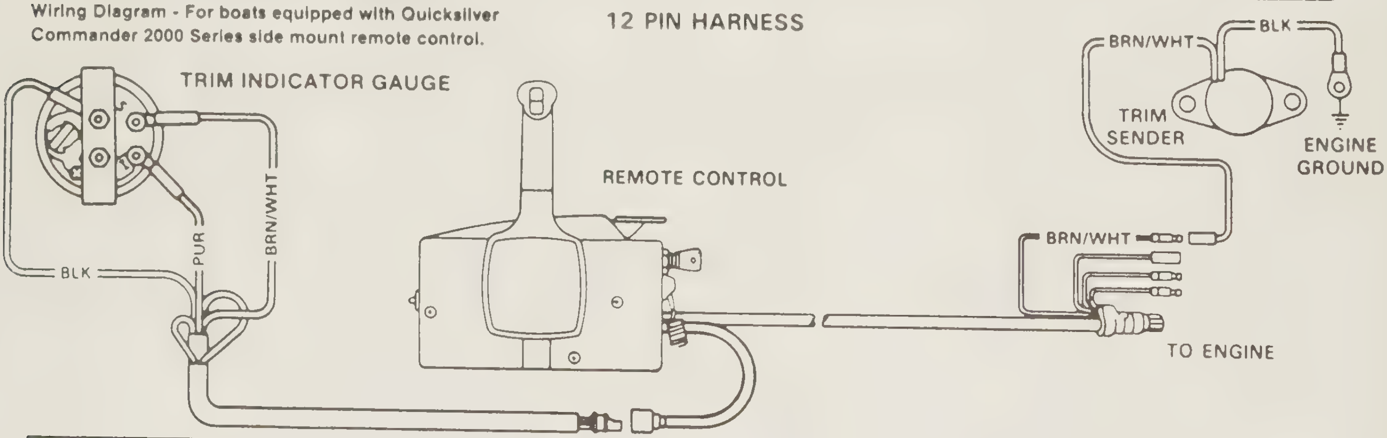
Wiring Diagram - For boats equipped with Quicksilver Ignition/Choke and Main Harness Assembly

8 PIN HARNESS



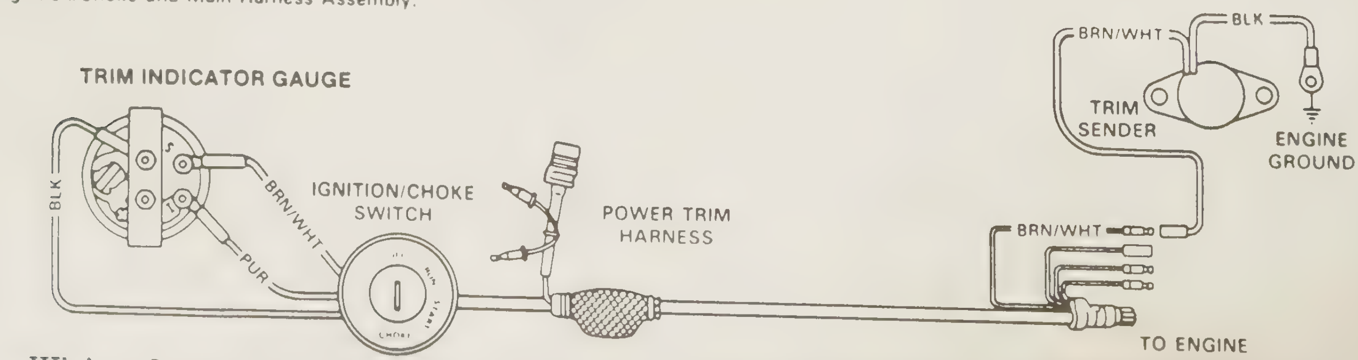
Wiring Diagram - For boats equipped with Quicksilver Commander 2000 Series side mount remote control.

12 PIN HARNESS

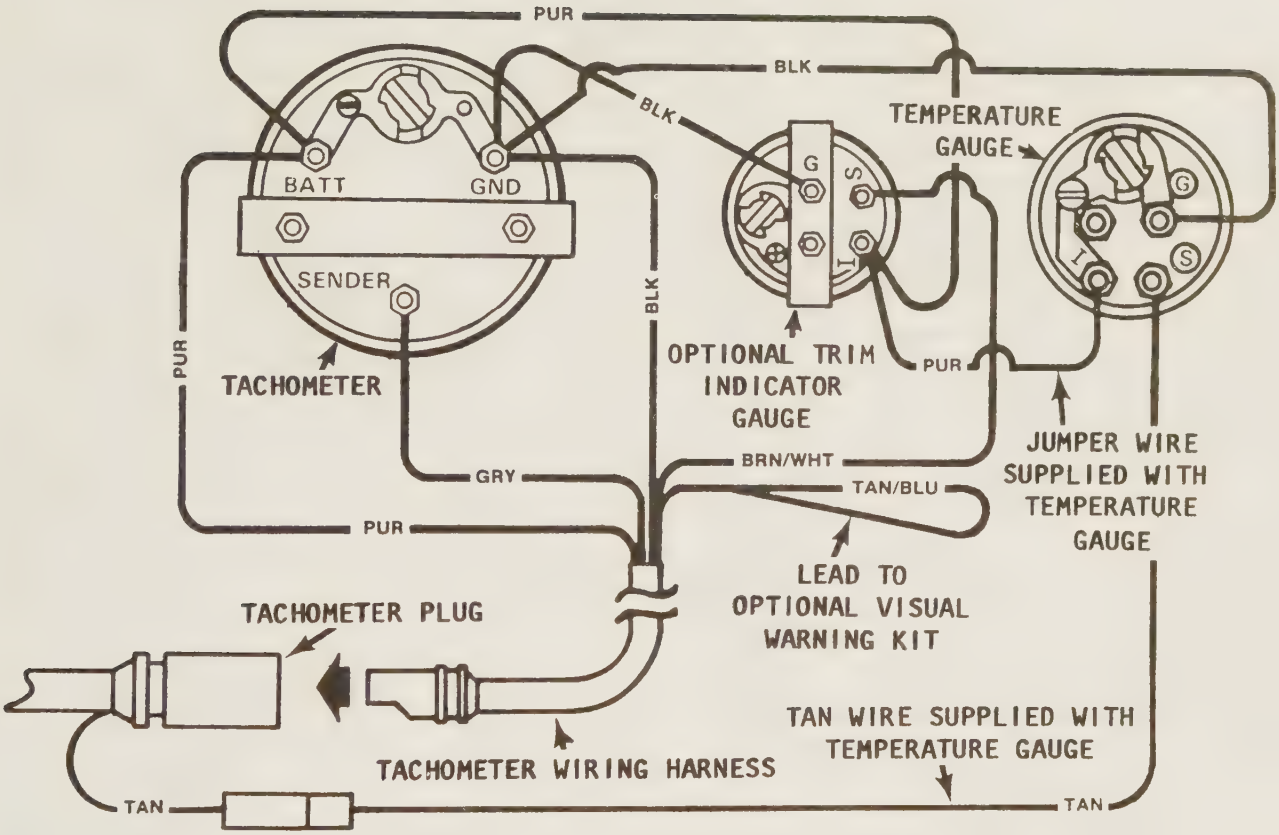


Wiring Diagram - For boats equipped with Quicksilver Ignition/Choke and Main Harness Assembly.

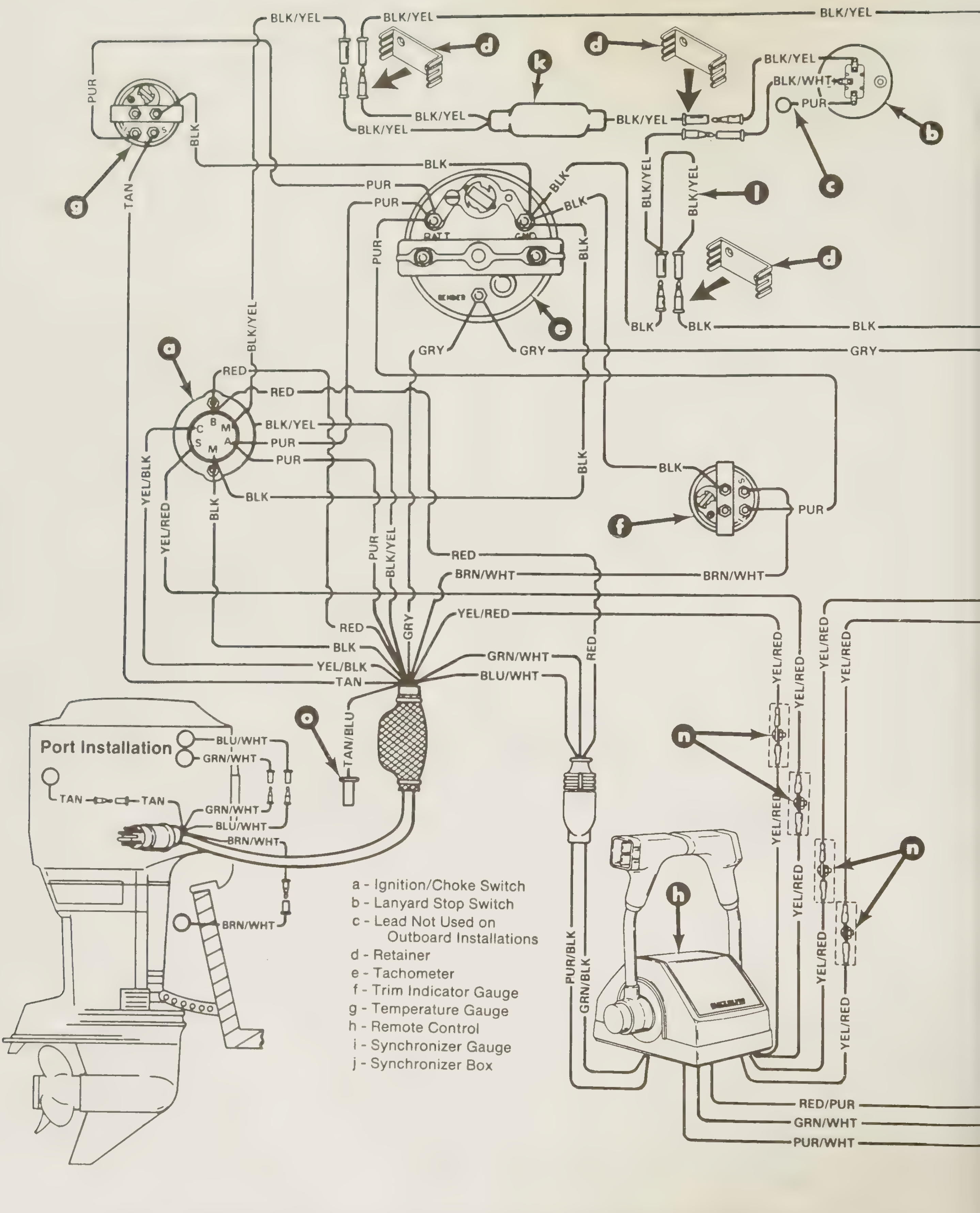
12 PIN HARNESS



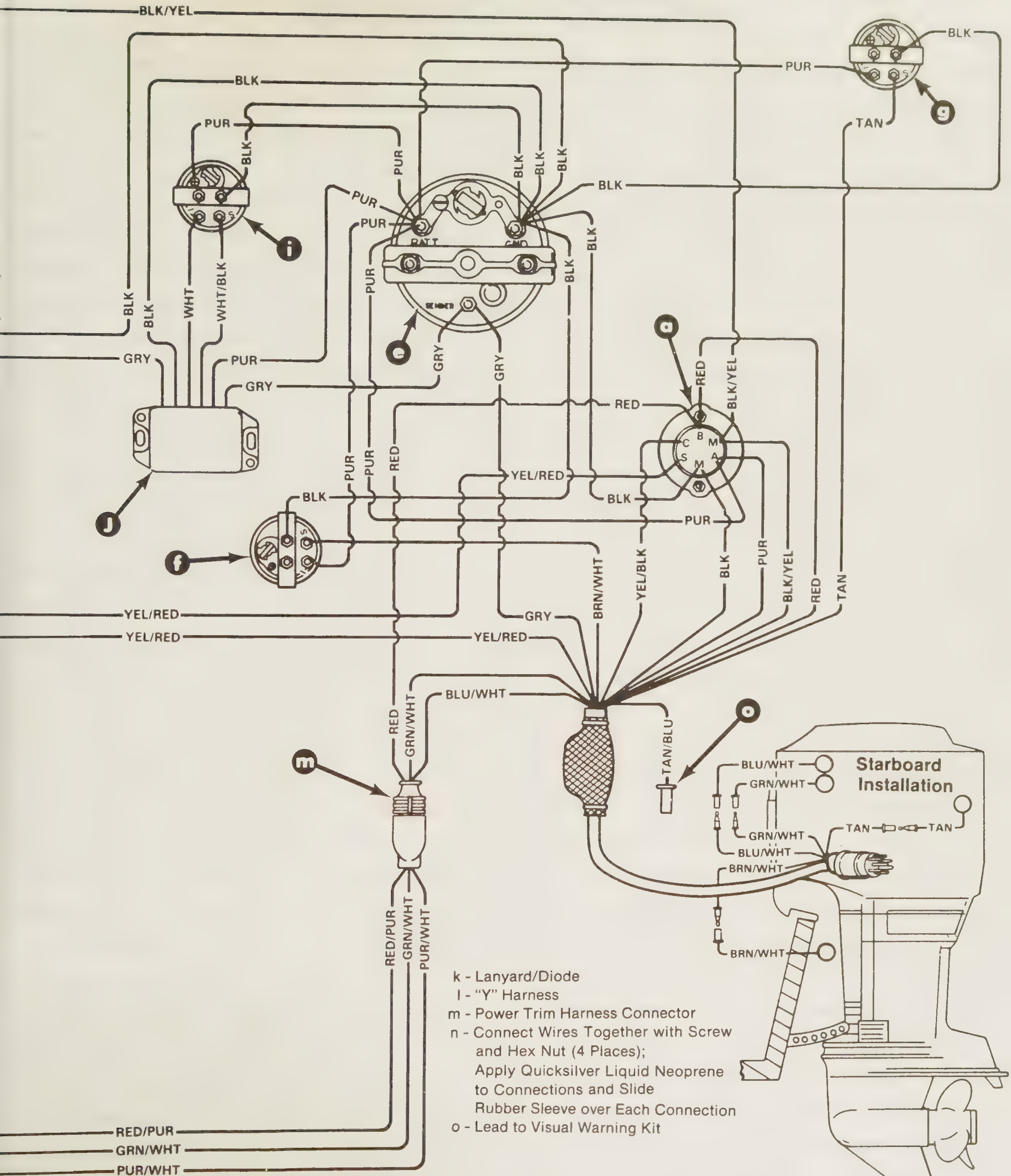
Wiring diagram with color code identification for various trim indicator gauge and trim sender installation, as indicated on the drawings.



Wire identification -- Instrument panel -- single outboard installation using Quicksilver "Commander" 2000 remote control.



*Wire identification -- Dual outboard instrument setup for **PORT** outboard unit.*



k - Lanyard/Diode
l - "Y" Harness
m - Power Trim Harness Connector
n - Connect Wires Together with Screw and Hex Nut (4 Places); Apply Quicksilver Liquid Neoprene to Connections and Slide Rubber Sleeve over Each Connection
o - Lead to Visual Warning Kit

IMPORTANT: On installations where gauge options will not be used, tape back and isolate any unused wiring harness leads.

*Wire identification -- Dual outboard instrument setup for **STARBOARD** outboard unit.*

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